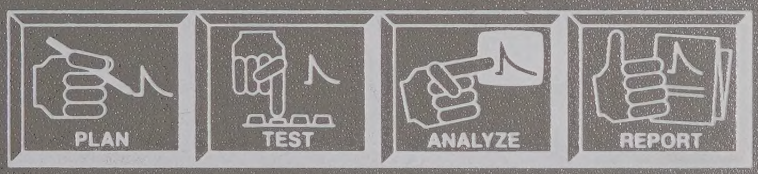
Operating Instructions

ECAT™

Pulsed-EMI Test System



ECAT™

Expert Computer-Aided Testing
for Pulsed EMI Immunity

ESD • EFT • SURGE • PQF™

KeyTek

Reporting Software

Operating Instructions

ECAT™

Pulsed-EMI Test System

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Version 1, September 1993

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Table of Contents

Chapter 1 Introduction **1**
Overview 1
Software Versions 1

Chapter 2 Installation **2**

Chapter 3 Operation **3**
Using Reporting in SurgeWare 3
Using Reporting in BurstWare 4
Logfile Setup 4
The Logfile Start Window 5
Inserting Comments in the Logfile 6
Report Format - Text 8
Report Format - Export 9
Example: Exporting data into Excel 10

Table of Contents

List of Figures

Figure

3-1 Log Pull Down Menu 3
3-2 Logfile Setup Window 4
3-3 Logfile Start Window 5
3-4 Insert Comment Button 6
3-5 Comment Window 7
3-6 Operator Pause Window for Time Critical Comment Log Entries 7
3-7 Logfile Imported into Excel 11

List of Figures

Figure

1-1 Lee Hall Dorm Menu 1
3-1 Legible Snow Window 4
3-2 Legible Sun Window 5
3-3 Illegible Dimmer Button 6
3-4 Illegible Window 7
3-5 Illegible Pause Window for Time Delay Entries 9
3-6 Illegible Updated Menu Card 11

Chapter 1
Introduction

This document explains the installation and use of the new test reporting functions available in SurgeWare and BurstWare, Versions 3.20 or higher. This is a supplement to the Operating Instructions, ECAT Pulsed-EMI Test System document.

Overview

The reporting feature of SurgeWare and BurstWare provides an integrated means for documenting the design and results of a specific test. The test log feature is used for collecting all pertinent test data regarding test conditions, test design, and test results just as a test technician would collect data in a handwritten log. Among the many available features are:

- User selectable filenames
- Logfiles can be saved in an ASCII text format or an exportable format suitable for importing into a spreadsheet or database
- Files may be appended to existing files or may be set to overwrite existing files
- A new logfile may be selected at the beginning of each new test sequence
- Each new test allows the name of the operator, EUT and any comments to be added to the logfile
- Each logfile contains a complete listing of the test sequence and conditions, including modules used, the time and date of test events and the results of each test
- Operator comments may be added to the logfile at any time during the test

Software Versions

The reporting feature is available as part of SurgeWare Version 3.20 and later, as well as BurstWare Version 3.20 and later. If you do not have the current version of either software package, contact KeyTek to arrange for an upgrade.

Chapter 2
Installation

The SurgeWare and BurstWare software products are supplied on a single diskette. They are designed to run on an external computer under Microsoft Windows, Version 3.1 or later. Installation has been automated using the SETUPKT installation program. Use the following procedure to install the software on your system.

1. Insert the ECAT release diskette into the disk drive.
2. From the Program Manager, File Manager, or an equivalent windows shell, pull down the file window and select RUN.... Windows then displays a dialog box requesting the name and path of the program to be run.
3. Enter the disk drive path, followed by the name of the installation program. For example: A:\SETUPKT.EXE
4. Click OK.
5. Follow the instructions on the screen to complete the installation.

Setup copies the ECAT programs, libraries, data files, and some demo programs onto the hard disk, creating a program group called KeyTek Control. The program group contains icons for SurgeWare, BurstWare, and PQFWare.

6. Using File Manager, check for a file called README.TXT on the distribution diskette. If the file exists, print it out or read it using the Windows Notepad to obtain updated information about the software.

Chapter 3
Operation

Using Reporting in SurgeWare

To use the reporting feature in SurgeWare, you must turn on the logging function. This logging function is used to create a log file that summarizes the test design and results, which can be used as the basis of a test report.

After starting SurgeWare in the normal manner, notice that the menu bar contains a new menu item: **Log(OFF)**. This menu item selects the pull down menu for the logging features. It also shows the current status of the log, i.e. ON or OFF, in parentheses. Figure 3-1 illustrates the log menu. Note that the log feature is shown here as being ON.

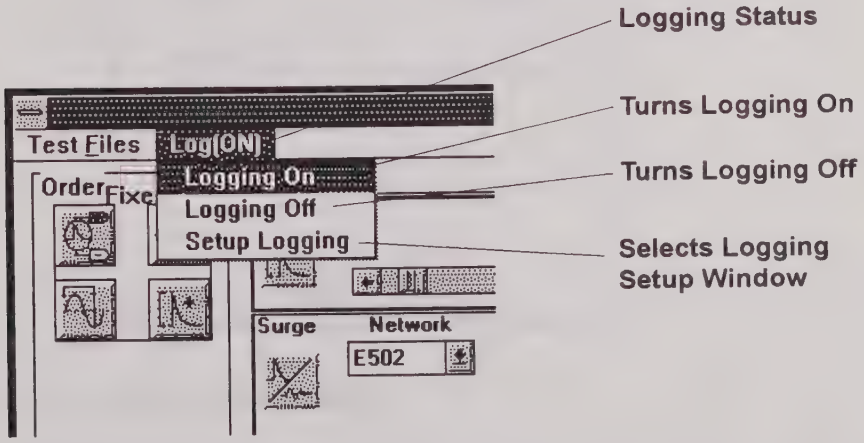


Figure 3-1. Log Pull Down Menu

To select, or turn ON, the logging function, click on the **Logging On** command. The drop down menu will disappear and the menu bar will show: **Log(ON).**

To deselect, or turn OFF, the logging function, click on the **Logging Off** command. The drop down menu will disappear and the menu bar will show: **Log(Off).**

To set up the defaults for the logfile, click on **Setup Logging**. The Logfile Setup window will appear. The use of this window is discussed below.

Using Reporting in BurstWare

To use the reporting feature in BurstWare, you must turn ON the logging feature exactly as described above for SurgeWare.

Logfile Setup

The Logfile Setup window is used to select defaults for the logfile generated by the test software. This window is illustrated in Figure 3-2.

Figure 3-2. Logfile Setup Window

The *Base Logfile Name* is the default filename for the logfile. A default filename is provided but may be changed. To change the name of the file, double-click on the filename box and type in the new filename. To select a filename already on disk, click on the **Select** button to bring up a directory window. Select a filename from a displayed directory by clicking on it once to

highlight it, and then clicking on **OK**. Alternately, double-click on the desired filename. The selected filename becomes the new default log file.

The logfile may be generated in several different ways. To accumulate several test sessions in one file, select the **Append** option under *Existing File Actions*. If you want only the last test run reported in the logfile, select the **Rewrite** option. **Inc Name** is not implemented at this time.

The *Output Format* may be specified for one of two options: **Text File** or **Export File**. Selecting the **Text** option generates an ASCII file test report. Selecting the **Export** option generates a file format that may be imported into a spreadsheet or database program.

When all of the desired defaults have been specified, click on the **OK** button to close the Logfile Setup window. If you decide not to change the defaults, click on the **Cancel** button and the existing selections will be used.

The Logfile Start Window

When initiating a test by clicking on the **Run** button, a Logfile Start Window appears as shown in Figure 3-3. This window is used to enter information specific to the setup and execution of the current test.

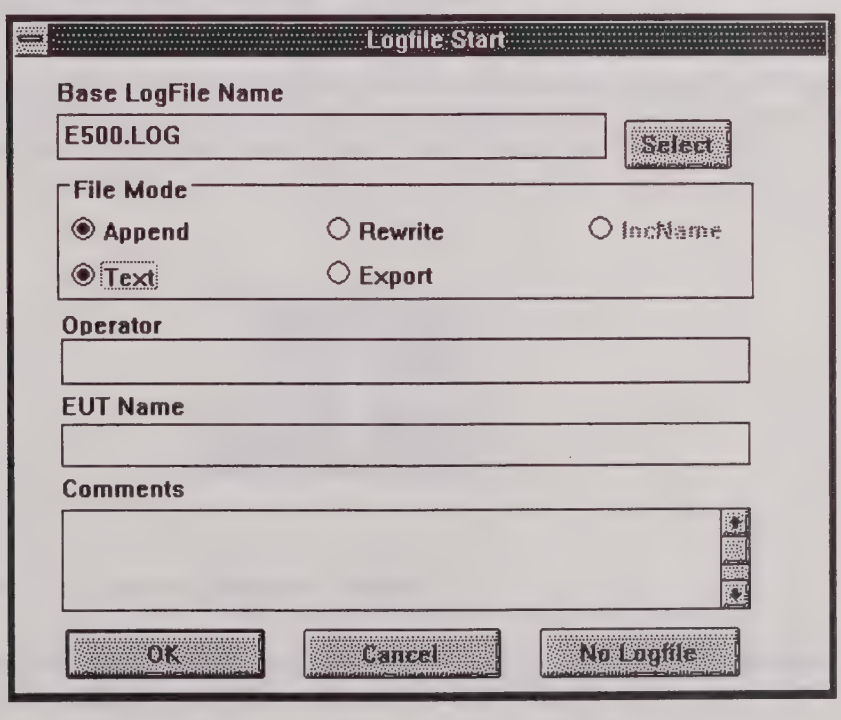
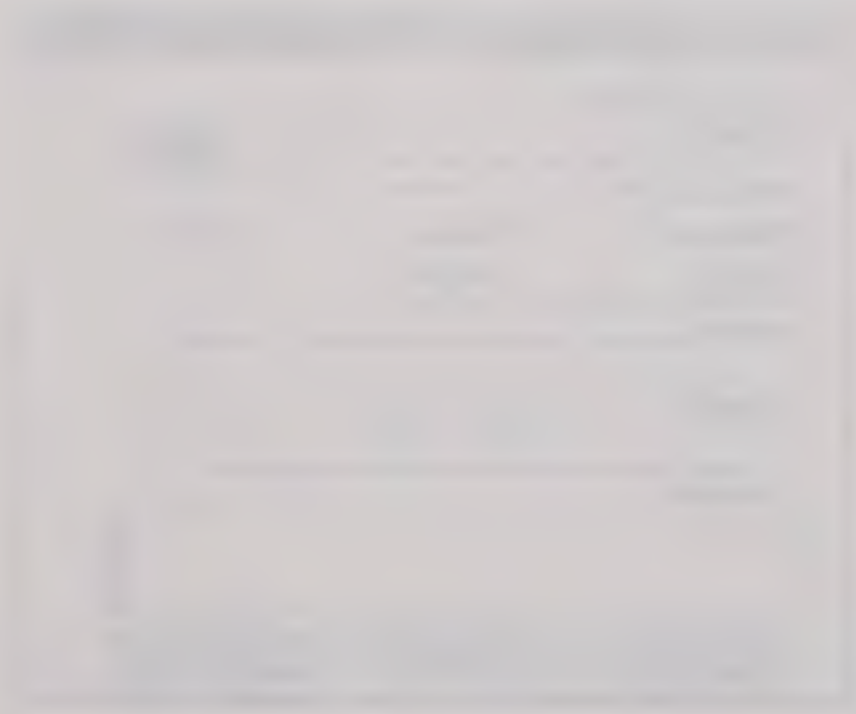


Figure 3-3. Logfile Start Window



The *Base Logfile Name* box and the *File Mode* box indicate the default options selected in the Logfile Setup window. These may be changed at this time if desired. To change the location of the logfile, click on the **Select** button and select a new drive and path.

The test technician enters his name in the *Operator* box. Click inside the box and type in the operator's name.

The Equipment Under Test (EUT) may be specified in the *EUT Name* box. Click inside the box and type in the name or other identification of the EUT.

A *Comments* box is provided for any other information that is pertinent to the test and should be added to the record of the test. Click inside the *Comments* box and type in any appropriate text. Do not use the Enter key to begin a new line or you will exit from the Logfile Start window.

When you are satisfied with the data entries for the logfile, you can click on the **OK** button to exit the Logfile Start window and begin the test. If you decide not to make changes to the data in the window, click on the **Cancel** button and the test will proceed with the default options.

If you decide that you do not want a logfile generated for this test, click on the **No Logfile** button. The test will proceed without generating a logfile.

Inserting Comments in the Logfile

During the course of a test, it may be necessary to make a note in the logfile. This may be done in two different ways. If the comment is not *time critical*, click on the **Comment** button located below the **Stop** button on the main SurgeWare or Burst Ware display. This button is shown in Figure 3-4.

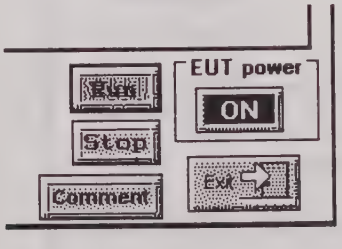


Figure 3-4. Insert Comment Button

A Comment window will pop up as shown in Figure 3-5. Enter the desired comment and click on the OK button: the comment is then inserted into the logfile with a timestamp

corresponding to the moment that the OK button was clicked. The test is not interrupted while the comment window is displayed. The test may even end before the comment is completed. The window may be closed after the comment is entered, or cancelled by clicking on the Cancel button.

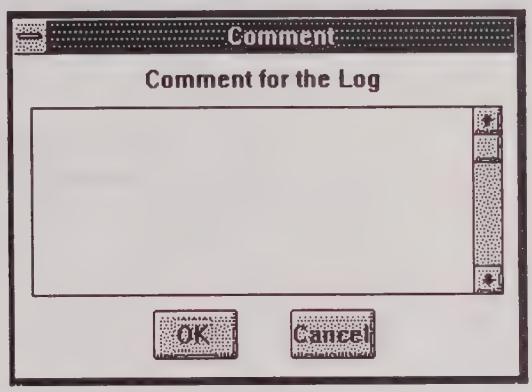


Figure 3-5. Comment Window

If the comment is *time critical,* an alternate procedure is used to insert comments with a time stamp. First, the test is paused by clicking on the **Stop** button. The window in Figure 3-6 pops up. Comments may be entered in the comment area at the bottom of the window. When the comment has been entered, click on the **Run** button to resume the paused test sequence. This window may also be used to make a terminating comment for that test run.

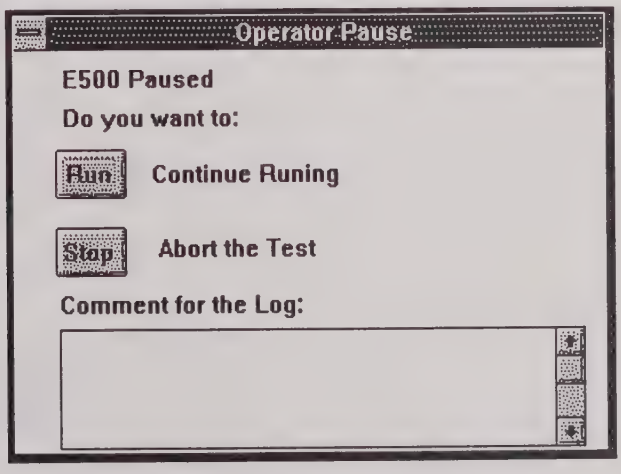


Figure 3-6. Operator Pause Window for Time Critical Comment Log Entries

Report Format - Text

The Text formatted logfile is an ASCII text file listing all of the test data previously discussed. It has no special formatting and may be edited with a screen editor or word processor of your choice. The sample listing below is an example of a test file generated from a BurstWare test simulation. The SurgeWare generated report is similarly structured.

Sample Listing:

KeyTek Instrument Co. ECAT Log File
Software:E400 Burstware V3.20 (c)1993
Firmware:Simulated
Modules:
Row 1 Right:E502 SN:1
Row 1 Left :E501 SN:2
Row 2 Right:E505 SN:3
Row 2 Left :E503 SN:4
Row 3 Right:E411 SN:5
Row 3 Left :E511 SN:6
Row 4 Left :E4554 SN:7
Row 5 Left :EP61 SN:8
Test Started at 13:43.09 on SEP 21,1993
Test File:C:\KEYTEK\ECAT\KILROY.EFT
Operator :Murphy
EUT:Prototype No. 1
Comments: Comment made in Logfile Start window.
Coupling:Front
Voltage:Fixed 1000 V
Polarity:Positive
Units:mSec
Frequency:Fixed 1000 Hz
Period:Fixed 300 ms
Phase:Fixed 0 dg
Duration:Fixed 15 mS
Repeat:3
E400:Wait time 10 Seconds
E400:Duration time 1 Second
E400:EUT power:OFF
E400:Phase Mode Period
E400:Order:Repeat

Time Action Volts(V) Freq Dur. Period Phase Source At Cpl
13:43.09:Burst 1000 1000Hz 15mS 300 RND E411 E411 Out 1
13:43.10:EFT Step Ended
13:43.13:Operator Paused Test
13:43.49:Time critical comment made in Operator Pause window.
13:43.49:Operator Continues Test
13:43.57:Burst 10001000Hz 15mS 300 RND E411 E411 Out 1
13:43.58:EFT Step Ended
13:44.07:Random Comment.
13:44.09:Burst 10001000Hz 15mS 300 RND E411 E411 Out 1
13:44.10:EFT Step Ended
13:44.10:Test Complete
13:44.10:Log Closed

Report Format - Export

The Export formatted logfile is an ASCII file structured for importing into a database or spreadsheet program such as Microsoft Excel™. This version of the logfile is essentially the same as the ASCII version with the exception of the test results data which is tab delimited. A sample of the tab delimited section of the test file generated by BurstWare is shown in the following listing. A SurgeWare generated report is similarly structured.

Sample Partial Listing:

Time	Action	Volts(V)	Freq	Dur.	Period	Phase	Source	At	Cpl
13:43.09:	Burst	1000	1000 Hz	15 mS	300	RND	E411	E411	Out 1
13:43.10:	EFT Step Ended								
13:43.13:	Operator Paused Test								
13:43.49:	Time critical comment made in Operator Pause window.								
13:43.49:	Operator Continues Test								
13:43.57:	Burst	1000	1000 Hz	15 mS	300	RND	E411	E411	Out 1
13:43.58:	EFT Step Ended								
13:44.07:	Random Comment.								
13:44.09:	Burst	1000	1000 Hz	15 mS	300	RND	E411	E411	Out 1
13:44.10:	EFT Step Ended								
13:44.10:	Test Complete								
13:44.10:	Log Closed								

Example: Exporting data into Excel

It is common practice to corollate and analyze test data in a spreadsheet program such as Excel. The Export formatted logfile test report is designed to be imported into such a program.

Two things should be done before running the test.

1. Change the *Base LogFile Name* and path specifications to place the logfile in Excel's working directory.
2. Specify *Export* under *File Mode* for the logfile.

These steps may be done in the Logfile Setup window or in the Logfile Start window.

To import the logfile into Excel, first start the program by double clicking the Excel icon. Then, select **Open** from the File menu or click on the *open file folder* icon button. Select the ***.*** File type. Then select the logfile by clicking on the filename to highlight it and then clicking on the **OK** button. The logfile will appear in Excel's main window and may be edited as a standard spreadsheet.

After importing the logfile into Excel in this manner, it is a good idea to save the spreadsheet as an Excel file.

Figure 3-7 illustrates how the export logfile previously shown would appear after being imported into Excel.

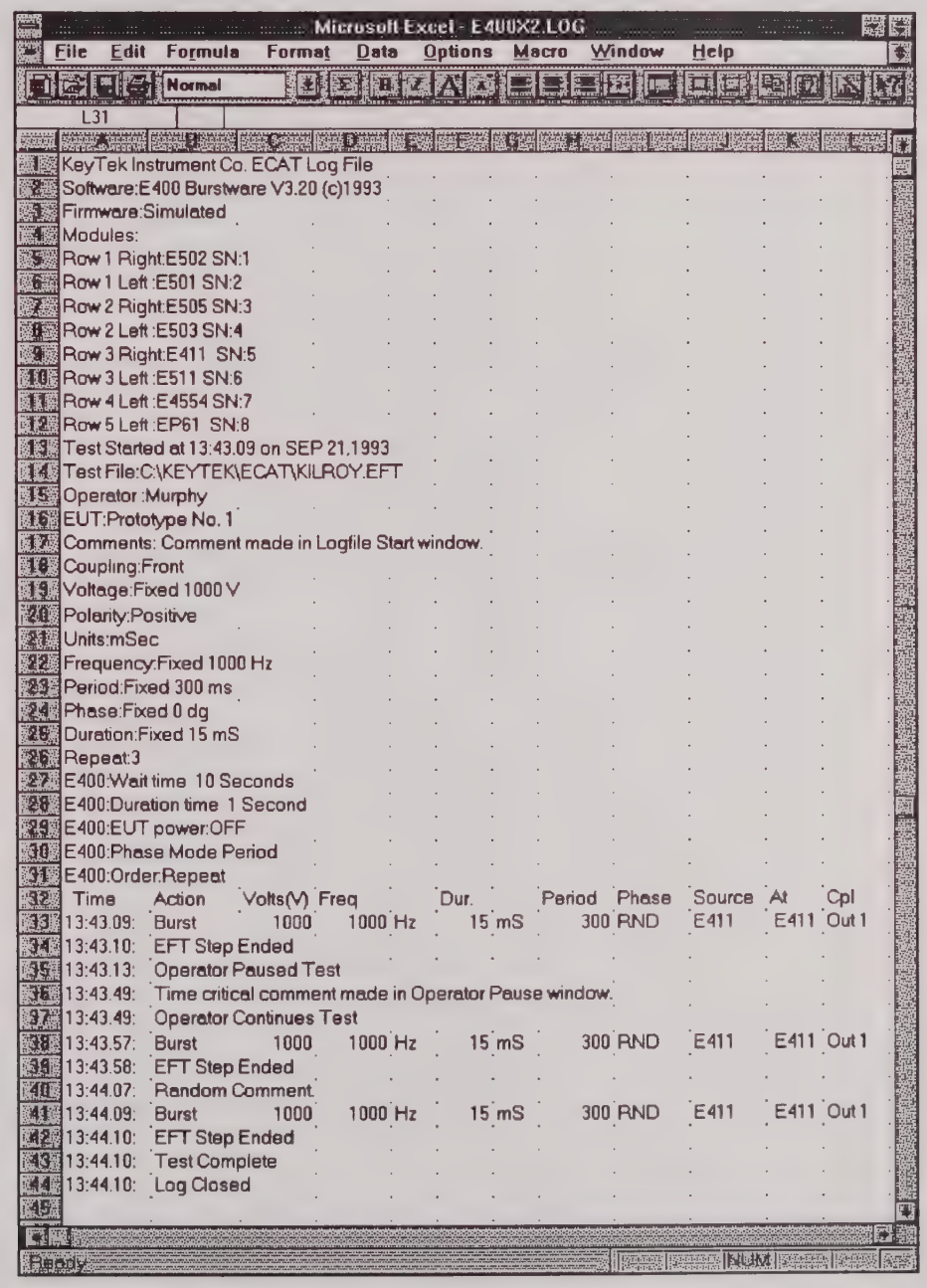

Microsoft Excel - E400X2.LOG
File Edit Formula Format Data Options Macro Window Help
Normal
L31
KeyTek Instrument Co. ECAT Log File
Software:E400 Burstware V3.20 (c)1993
Firmware:Simulated
Modules:
Row 1 Right:E502 SN:1
Row 1 Left :E501 SN:2
Row 2 Right:E505 SN:3
Row 2 Left :E503 SN:4
Row 3 Right:E411 SN:5
Row 3 Left :E511 SN:6
Row 4 Left :E4554 SN:7
Row 5 Left :EP61 SN:8
Test Started at 13:43.09 on SEP 21,1993
Test File:C:\KEYTEK\ECAT\KILROY.EFT
Operator :Murphy
EUT:Prototype No. 1
Comments: Comment made in Logfile Start window.
Coupling:Front
Voltage:Fixed 1000 V
Polarity:Positive
Units:mSec
Frequency:Fixed 1000 Hz
Period:Fixed 300 ms
Phase:Fixed 0 dg
Duration:Fixed 15 mS
Repeat:3
E400:Wait time 10 Seconds
E400:Duration time 1 Second
E400:EUT power:OFF
E400:Phase Mode Period
E400:Order:Repeat
Time Action Volts(V) Freq Dur. Period Phase Source At Cpl
13:43.09: Burst 1000 1000 Hz 15 mS 300 RND E411 E411 Out 1
13:43.10: EFT Step Ended
13:43.13: Operator Paused Test
13:43.49: Time critical comment made in Operator Pause window.
13:43.49: Operator Continues Test
13:43.57: Burst 1000 1000 Hz 15 mS 300 RND E411 E411 Out 1
13:43.58: EFT Step Ended
13:44.07: Random Comment
13:44.09: Burst 1000 1000 Hz 15 mS 300 RND E411 E411 Out 1
13:44.10: EFT Step Ended
13:44.10: Test Complete
13:44.10: Log Closed
Ready
NUM

Figure 3-9. Logfile Imported into Excel

Operating Instructions

ECAT™

Pulsed-EMI Test System

KeyTek®

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a subsidiary of

Thermo Voltek Corp. &

Thermo Electron Corporation

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Wilmington, MA 01887 USA

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Version 2, July, 1993

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Product Safety Information

Definition of Safety-related Symbols

The lightning flash with arrowhead symbol within an equilateral triangle is intended to alert the user of the presence of uninsulated *dangerous voltages* within the product enclosure that may be of sufficient magnitude to constitute a risk of electric shock to personnel.

The exclamation point within an equilateral triangle is intended to alert the user of the presence of important operating and maintenance (servicing) instructions in the literature accompanying the product.

Cautions and Warnings

CAUTION

RISK OF ELECTRIC SHOCK
DO NOT OPEN

TO REDUCE THE RISK OF ELECTRIC SHOCK, DO NOT REMOVE COVER OR BACK.
NO USER-SERVICEABLE PARTS INSIDE.
REFER SERVICING TO QUALIFIED SERVICE PERSONNEL.

WARNING

TO PREVENT FIRE OR SHOCK HAZARD,
DO NOT EXPOSE THIS EQUIPMENT TO RAIN OR MOISTURE.

Safety Instructions

The following safety instructions have been included in compliance with safety standard regulations. Please read them carefully.

- **Read Instructions** - Read all safety and operating instructions before operating the instrument.
- **Retain Instructions** - Retain all safety and operating instructions for future reference.
- **Heed Warnings** - Adhere to all warnings on the instrument and in the operating instructions.
- **Follow Instructions** - Follow all operating and use instructions.
- **Water and Moisture** - Do not use the instrument near water.
- **Carts and Stands** - Use the instrument only with a cart or stand that is recommended by or included as part of the ECAT™ system by the manufacturer. An instrument and cart combination should be moved with care. Quick stops, excessive force, and uneven surfaces may cause the instrument and cart combination to overturn.
- **Wall or Ceiling Mounting** - Do not mount the instrument on a wall or ceiling.
- **Ventilation** - The instrument should be situated so that its location or position does not interfere with its proper ventilation. Do not install in a cabinet or other situation that may impede the flow of air through the ventilation openings.
- **Heat** - The instrument should be situated away from heat sources such as heat registers or other instruments which produce heat.
- **Power Sources** - Connect the instrument only to the type of power source described in the operating instructions or as marked on the instrument.
- **Grounding or Polarization** - Take precautions to ensure that the grounding or polarization means of the instrument is not defeated. The EUT PE (protective Earth) terminal is not connected to the ECAT system ground. Do not defeat EUT PE ground.
- **Power Cord Protection** - Position power supply cords so that they are not likely to be walked on or pinched by items placed upon or against them. Pay particular attention to cords at plugs, convenience receptacles, and the point where they enter and exit the instrument.
- **Cleaning** - Clean the instrument only as recommended by the manufacturer.
- **Non-use Periods** - Unplug the power cord of the instrument from the outlet when it will be left unused for a long period of time.

- **Lifting and Carrying** - When removing an instrument module from the ECAT system follow the instructions given in Chapter 3 under Removing and Installing Instrument Modules. Most half-width modules can be lifted by one person. Full-width modules require two persons.
  Do not slide an instrument module out of the ECAT cabinet by pulling on the clear plastic door on the front of the module.
  Do not lift an instrument module using the clear plastic door.
- **Hold-in Screws for Modules** - Be sure that the hold-in screws for each instrument module are installed and tightened before attempting to use the ECAT system. Half-width modules have a single hold-in screw located at the bottom center of the module. Full-width modules have two hold-in screws located along the bottom of the module about four inches in from each side.
- **Banana Sockets** - The banana connectors on the ECAT instrument modules are gold plated, and rated for 32 A. For safety reasons, and to ensure that the connectors will not deteriorate over time, always use gold plated banana plugs of at least the same rating.
- **Object and Liquid Entry** - Take care that objects do not fall and liquids are not spilled into the enclosure through openings.
- **Defects and Abnormal Stress** - Whenever it is likely that the normal operation has been impaired, make the equipment inoperable and secure it against any further operation. Normal operation is likely to be impaired if, for example, the instrument:
  - Shows visible damage
  - Fails to perform the intended functions
  - Has been subjected to prolonged storage under unfavorable conditions
  - Has been subjected to severe transport stresses
- **Damage Requiring Service** - The instrument should be serviced by qualified service personnel when:
  - The power supply cord or the plug has been damaged
  - Objects have fallen or liquid has been spilled into the instrument
  - The instrument has been exposed to rain
  - The instrument does not appear to operate normally or exhibits a marked change in performance
  - The instrument has been dropped, or the enclosure has been damaged
- **Sitting or Climbing** - Do not sit on or climb upon the equipment or use it as a step or ladder.

Surge Testing Guidelines

- **DO NOT WORK ALONE.**
- Do not use the equipment in conditions other than reasonable laboratory conditions. There should be no condensing humidity or water standing on the floor or work surfaces; there shouldn't be significant dust or other contamination.
- Ensure that **NO ONE** is touching the equipment under test (EUT) during the test or immediately after the test until AC power to the EUT has been turned off.
- Ensure that there is a **barrier** to act as protection in case the equipment under test explodes. This may happen due to power-follow after a failure. The barrier should be interlocked to prevent surging and to disconnect all AC if the barrier is removed.
- The equipment under test must be surrounded by sufficient **insulating material** to withstand twice the surge voltage. Consider distance to the floor or table and walls if air is the insulating material
- Ensure that the **proper supply mains** voltages are applied to both KeyTek® equipment and to the equipment under test, and that the AC branch circuit is capable of supplying the current.
- The ground (protective earth), neutral and phase lines of the AC supply to the equipment under test supply must be connected properly. **Do not defeat the protective earth connection.**
- The ground (protective earth), neutral and phase lines of the AC supply to the KeyTek equipment must be connected properly. **Do not defeat the protective earth connection.**
- When surging a powered EUT, the mains supply to the equipment under test must be capable of handling the potential AC fault current (e.g. do not use a UPS to power the EUT).
- Never surge an AC mains line that is connected to equipment other than the equipment under test without a backfilter to protect the other equipment.
- Use only equipment which is designed to be safe for the test being performed.
- Do not test in a potentially explosive atmosphere (e.g. gas fumes).
- Never use equipment that is operating in a strange manner, or that shows clear indication of abuse.
- If probes are in use, be sure they are differential probes which have no ground connection to the surged ground or to the equipment under test.

Safety Concerns During Surge Testing

Surge testing is hazardous. The equipment under test (EUT) can ignite, possibly explosively. Noxious, toxic and sometimes fatal fumes can be generated by the burning equipment. Accumulated gases may ignite explosively (i.e., *flashover*).

In an environment where surge testing takes place, it is absolutely crucial that these minimum safety precautions be taken:

- Surge testing should be performed only by properly trained test personnel who are experienced in conducting such tests, or be observed and supervised by such experienced personnel. No person subject to heart or neurological conditions should be allowed to conduct surge tests. Persons with pacemakers should not be allowed in or near the area where testing is conducted.
- Never leave a procedure or a test setup unattended.
- All personnel working in the area must be shielded with appropriate eye protection, body protection and electrical protection. They should not be allowed to work in a direct line of a possible explosion of the equipment under test.
- The test area should be a clear and unobstructed environment dedicated to such tests.
- The test area should be equipped with ventilating hoods and blowers to remove gases that may be caused by exploding or burning components.
- The test area should have nonflammable walls and floors plus shielding to contain exploding parts and flames.
- There must be fire extinguishers certified for use in electrical and chemical fires readily available at the test site. **DO NOT USE WATER TO EXTINGUISH AN ELECTRICAL FIRE.**
- All flammable materials and debris must be outside the test area, and the area must be well marked, preferably by physical barriers, to prevent accidental intervention by non-test personnel while a test is in progress

Table of Contents

Product Safety Information iii
Table of Contents ix
List of Figures xv
List of Tables xvii

Chapter 1 Introduction 1-1
Overview of this Manual 1-1
ECAT - The Total System 1-2
KeyTek Turn-Key Testing 1-2
Versatile, Modular Architecture 1-3
Faster, Easier, More Accurate Testing 1-3
Failure Diagnosis 1-4
AC Mains Measurements 1-5
ECAT Instrument Groups 1-5
Surge Testing 1-5
Power Quality Failure Testing 1-7
Electrical Fast Transient and Burst Testing 1-8
The New EMC World - What is it, Why Should You Care? 1-9

Chapter 2 System Description 2-1
Three System Examples 2-1
Control Center and Cabinet 2-5
Instrument Modules 2-6
Surge Networks and Coupler/Decouplers 2-6
Surge Networks 2-6
Coupler/Decouplers 2-9
Mains Coupler/Decoupler 2-10
I/O Line Coupler/Decoupler 2-10

PQF Simulators 2-12
EFT Sources and Coupler/Decouplers 2-15
Measurement Capability 2-18
Surge Network Measurement Options 2-20
PQF Measurement Options 2-21
EFT Measurement Options 2-21
Coupler/Decoupler Measurement Options 2-21
FiberLoop 2-22

Chapter 3 Installing the ECAT System 3-1
Test Area Considerations and Site Preparation 3-2
Safety Barriers, Interlocks 3-3
EUT Power 3-4
Special Considerations for EFT/Burst Testing 3-6
Ground Reference Plane and Equipment Spacing 3-6
Incoming Inspection and Unpacking 3-8
Unpacking the Benchtop System 3-8
Unpacking a Floor-standing (Roll-around) System 3-11
Physical Installation 3-12
Electrical Installation 3-13
Instrument AC Connections 3-13
EUT Mains Connections 3-13
Coupler/Decoupler Mains Connections 3-14
Test Connections 3-14
Surge Voltage Monitor Input Jumpers 3-16
Two Specialized Surge Measurement Configurations 3-17
FiberCom Connections 3-18
Fiberoptic Connection 3-19
RS-232 Connection 3-19
FiberLoop Connections 3-19
Firmware and Software Installation 3-20
Firmware 3-20
Microsoft Windows Software 3-20
Changing the COM Port 3-21
Initial Power Up 3-22
Removing and Installing Instrument Modules 3-24

To Remove a Module 3-24
To Install a Module 3-25

Chapter 4 Familiarization 4-1
Getting Familiar With the ECAT System 4-2
Powering Up 4-2
Familiarization with the Virtual Front Panel (VFP) 4-4
VFP Display Contrast Adjustment 4-4
VFP Familiarization, Surge 4-4
VFP Familiarization, PQF 4-7
VFP Familiarization, EFT 4-8
Becoming Familiar with the Windows-based Software 4-10
Windows Software Familiarization, SurgeWare 4-10
Windows Software Familiarization, BurstWare 4-12
Windows Software Familiarization, PQFWare 4-14
Performing Simple Surge Tests 4-16
Wiring the Measurement Inputs 4-16
Open Circuit Surge Test 4-18
Setting Up the Scope to Measure Open Circuit Voltage 4-18
Open Circuit Surge Test Using the Virtual Front Panel 4-19
Set up the Surge Test 4-19
Set up the Measurements 4-19
Verify Interlocks and Fire the Surge 4-19
Open Circuit Surge Test Using SurgeWare 4-21
Set up the Surge Test 4-21
Verify Interlocks and Fire the Surge 4-21
Short Circuit Surge Test 4-22
Wire the Simulator for Short Circuit Surge 4-22
Set Up the Scope to Measure Short Circuit Current 4-22
Short Circuit Surge Test Using the Virtual Front Panel 4-23
Short Circuit Surge Test Using SurgeWare 4-24
EUT Mains Control and EUT Power Interlocks Under Surge 4-24
Using the Virtual Front Panel 4-24
Using SurgeWare 4-25
Surge Line Sync Operation 4-26
Using the Virtual Front Panel 4-26

Using SurgeWare 4-28
Performing Simple PQF Tests 4-28
Generating a Simple Notch Waveform 4-28
Set up the Oscilloscope 4-29
Running the Test From the Virtual Front Panel 4-30
Running the Test From PQFWare 4-30
Generating a Simple Sag Waveform 4-32
Set up the Oscilloscope 4-32
Run the Test From VFP 4-32
Run the Test From PQFWare 4-34
Performing a Simple EFT/Burst Test 4-34
Setting up the EFT/Burst Test 4-35
From the Virtual Front Panel 4-35
From BurstWare 4-35
Three Oscilloscope Setups 4-36
To Observe Frequency of Pulses in a Burst 4-36
To Observe Duration of a Burst 4-38
To Observe Burst to Burst Period 4-40

Chapter 5 Operating the ECAT System 5-1
Understanding the Control Center 5-2
Understanding the Virtual Front Panel 5-6
Virtual Front Panel Controls 5-7
Selecting and Modifying Parameters in the VFP Menu 5-7
Power Up Self Test Display 5-9
Surge Testing from the Virtual Front Panel 5-10
Surge Test Menu 5-11
Surge Measurement Menu 5-16
EFT/Burst testing from the Virtual Front Panel 5-18
EFT/Burst Test Menu 5-19
PQF testing from the Virtual Front Panel 5-22
PQF Menu 5-23
Understanding SurgeWare 5-26
Surge Testing from SurgeWare 5-36
Example: Building a Test Sequence 5-36
Initial Setup 5-37

Defining the Test List for Voltage 5-37
Defining the Test Range for Phase 5-38
Specifying Repeating Tests 5-39
Modifying the Order of Events 5-39
Understanding BurstWare 5-40
EFT/Burst Testing from BurstWare 5-50
Example: Building a Test Sequence 5-51
Initial Setup 5-51
Defining the Test List for Voltage 5-51
Defining the Test Range for Frequency 5-52
Modifying the Order of Events 5-53
Understanding PQFWare 5-54
PQF Testing from PQFWare 5-59

Chapter 6 Maintenance, Troubleshooting 6-1
Annual Calibration 6-1
Five-year Factory Inspection and Refurbishment 6-1
Updating the ECAT Firmware 6-2
Updating the ECAT Firmware from Windows 6-3
Updating the ECAT Firmware from DOS 6-3
Troubleshooting 6-4

List of Figures

Figure		Page #
2-1.	Basic ECAT Surge Simulator in a Single-bay Cabinet	2-2
2-2.	Combined Surge and EFT Simulator in a Two-bay Cabinet	2-3
2-3.	Multi-function Surge plus EFT and PQF in Four-bay Cabinet	2-4
2-4.	Block Diagram, Surge Network and Coupler/Decoupler	2-7
2-5.	Block Diagram, PQF Simulator	2-13
2-6.	Block Diagram, EFT/Burst Source and Coupler/Decoupler	2-16
2-7.	Surge Voltage and Current Monitors and Peak Detectors	2-19
2-8.	FiberLoop, with Interlocks, and Voltage and RS-232 Monitors	2-23
3-1.	Reestablishing Neutral at an Isolation Transformer	3-5
3-2.	EFT Capacitive Coupling Clamp and Minimum Required Equipment Spacings	3-6
3-3a.	Equipment Configuration - Benchtop EUT	3-7
3-3b.	Equipment Configuration - Floor-standing EUT	3-7
3-4.	Shipping Package, Benchtop System	3-9
3-5.	Shipping Package, Floor-standing (Roll-around) System	3-11
3-6.	Direct Measurement Setup	3-18
3-7.	Control Center	3-23
4-1.	Control Center	4-3
4-2.	System Main Menu After Self Test	4-4
4-3.	Surge Test Menu	4-5
4-4.	Measurement Menu	4-5
4-5.	PQF Menu	4-7
4-6.	EFT Menu	4-8
4-7.	SurgeWare Display	4-11
4-8.	BurstWare Display	4-13
4-9.	PQFWare Display	4-15
4-10.	Voltage Measurement Jumpers	4-17
4-11.	Open Circuit Voltage Waveforms	4-20
4-12.	Short Circuit Current Waveform	4-23
4-13.	Scope Waveform	4-27
4-14.	Scope Waveform, PQF Notch	4-31
4-15.	Scope Waveform, PQF Voltage Sag	4-33

Figure **Page #**

4-16. Scope Waveform, Frequency Test 4-37
4-17. Scope Waveform, Duration Test 4-39
4-18. Scope Waveform, Burst to Burst Period Test 4-41
5-1. Control Center, Virtual Front Panel, and PC-based SurgeWare 5-1
5-2. Control Center 5-3
5-3. ECAT Virtual Front Panel (VFP) 5-6
5-4. Virtual Front Panel - Power Up Self Test 5-9
5-5. Surge Test Menu 5-11
5-6. Sample Surge Test Menu 5-12
5-7. Surge Measurement Menu 5-16
5-8. EFT/Burst Test Menu 5-19
5-9. PQF Menu 5-23
5-10. SurgeWare Display 5-27
5-11. BurstWare Display 5-41
5-12. PQFWare Display 5-54

List of Tables

Table		Page #
1-1.	Dominant Surge Standards and Applicable ECAT Modules	1-6
2-1.	Surge Networks, Description and Applicable Test Standards	2-8
2-2.	Coupler/Decoupler Features and Options	2-11
2-3.	PQF Capabilities and Options	2-14
2-4.	EFT/B Modules, Capabilities and Options	2-17
4-1.	Scope Set Up - Measure Open Circuit Voltage	4-18
4-2.	Scope Set Up - Measure Short Circuit Current	4-22
4-3.	Scope Set Up - Surge Line Sync Operation	4-26
4-4.	Scope Set Up - Simple Notch Waveform	4-29
4-5.	Scope Set Up - EFT/Burst - Observe Frequency of Pulses	4-36
4-6	Scope Set Up - EFT/Burst - Observe Duration of a Burst	4-38
4-7.	Scope Set Up - EFT/Burst - Observe Burst to Burst Period	4-40
5-1.	Surge Test Menu, Fields and Allowed Values	5-13
5-2.	VFP Surge Test Menu, Selections for Network (2nd field)	5-14
5-3	Surge Coupling Options for Coupler/Decouplers	5-15
5-4.	Measurement Menu, Choices for the Field Measurement Source	5-17
5-5.	EFT/Burst Menu, Fields and Allowed Values	5-20
5-6.	Coupling Options for EFT/Burst Coupler/Decouplers	5-21
5-7.	PQF Test Menu, Fields and Allowed Values	5-25
5-8.	Voltage Group Controls	5-28
5-9.	Surge Group Controls	5-29
5-10.	Coupling Group Controls	5-30
5-11.	Phase Group Controls	5-31
5-12.	Mode Controls in SurgeWare	5-34
5-13.	EFT Voltage Group Controls	5-42
5-14.	EFT Duration Group Controls	5-43
5-15.	EFT Frequency Group Controls	5-44
5-16.	EFT Period Group Controls	5-45
5-17.	EFT Coupling Group Controls	5-46
5-18.	Mode Controls in BurstWare	5-48
5-19.	Test Plan Edit Group Controls	5-57
6-1.	ECAT System Trouble Shooting Guide	6-4

Chapter 1
Introduction

KeyTek manufactures a wide variety of pulsed-EMI[1] simulation equipment. The ECAT™ (Expert Computer Aided Testing) Simulators described in this manual are the result of over two decades of pioneering experience during which KeyTek has consistently lead the industry with advanced technology and instruments. There are probably more KeyTek simulators in use around the world than all other makes combined.

At KeyTek, we take seriously our responsibility to furnish users with the finest equipment and software possible. If you have any suggestions for improving this system, we would be grateful if you would pass them along to us.

Overview of this Manual

This manual is designed for technicians and engineers responsible for the installation, setup and operation of the ECAT Simulators. It provides both an overview and a detailed description of the instrument and the procedures used to operate it. Note that this manual covers standard configurations as well as options that are available in the equipment series, and may describe functions and features not included in your system.

Product Safety Information, at the front of the manual, includes key guidelines for installing and operating the surge simulator in a safe manner.

Chapter 1, **Introduction**, summarizes the manual and introduces the equipment. It also introduces the ECAT system, and describes the instrument groups available for the system.

---

[1] Pulsed Electromagnetic Interference (EMI) includes: *Electrostatic Discharge* (ESD), *Electronic Fast Transients* (EFT) and *Surge*. ESD testing is performed by applying stimulus to the exterior surfaces of a device. EFT and Surge testing are performed by applying the stimulus to data and power lines.

Chapter 2, **System Description**, identifies the components of the system, describes its functional organization, and describes the test and measurements sequence.

Chapter 3, **Installing the ECAT System**, describes how to install the system, how to turn on the instrument for the first time, and how to check out the equipment.

Chapter 4, **Familiarization**, presents a series of procedures designed to quickly introduce the use of several common instrument modules. The material helps to quickly build familiarity with the system and can also serve to check out and qualify the instrument upon receipt.

Chapter 5, **Operating the ECAT System**, describes how to operate the system using both the local controls and an external computer. General information as well as information specific to each instrument group is included.

Chapter 6, **Maintenance, Troubleshooting**, describes the maintenance recommended by KeyTek. It includes instructions for removing and installing instrument modules and for upgrading system software and firmware. Note that there are no user-serviceable parts in the system. Repairs are to be performed only by KeyTek and its authorized dealers.

ECAT - The Total System

The ECAT System features a full line of test and simulation equipment for complete pulsed-EMI simulation and testing. ECAT represents a radical departure from present test equipment. ECAT was designed from the ground up to meet the rapidly evolving product reliability standards and economic realities of the new Electromagnetic Compatible (EMC) world. As a result, it provides many features and capabilities never even considered in previous simulation test instrument designs.

The ECAT system combines into one seamless control environment a spectrum of instruments capable of testing the immunity of electronic equipment to an unprecedented variety of threats. There is a single set of operating methods for all testing functions, and a unified facility for measuring the behavior of equipment under test (EUT) and for tracking failure modes.

KeyTek Turn-Key Testing

In the past, when you ordered a surge test system, all you received was the hardware. It was up to you to study the appropriate test standards and develop or assemble your own test program, including appropriate software.

With ECAT simulators, you get everything you need, including the software. The system is easily configured for testing to all the major national, international, and industry standards. The simulator includes basic software programs for conformance testing to these standards. With ECAT, it is no longer necessary to spend hours of research to run meaningful, accurate conformance tests.

For manual testing, programs guide you through sequences, step-by-step, resulting in repeatable, fully documented testing. In fully automatic and computer-managed operation, the software manages the entire test function, including automatic printouts of results.

Versatile, Modular Architecture

ECAT simulators are completely modular, using plug-in modules that provide a spectrum of waveforms for simulating all threats defined by the present mainstream standards for Surge, EFT, PQF (Power Qualify Failure) and ESD.

Any ECAT simulator can be readily expanded, at any time, for testing to new or modified standards and, when needed, to handle additional threats. There is no need to purchase new, separate instruments.

Because a complete, full capability ECAT system utilizes the same Control Center incorporating low-voltage and high-voltage power supplies, communications with an external computer and various monitoring capabilities require no costly redundancy.

Common, expandable-bay cabinetry and other design innovations contribute additional economies. Upgrades and multi-threat systems, therefore, are considerably less expensive than individual instruments. What's more, ECAT modular systems are totally open-ended; they will be able to handle future requirements, whatever they may be.

KeyTek's plug-in architecture protects you when standards are changed or superceded as the industry understanding of surge-generating phenomena improves, and industry standards evolve. KeyTek's plug-in waveform generators make it easier to upgrade the system in the future to meet customer-driven and industry-driven demands for more sophisticated products.

Faster, Easier, More Accurate Testing

An ECAT simulator provides totally unique operating features that enhance test reliability and greatly reduce test time. These include:

- *Constant Connections*™ - This feature permits the simulator to apply a number of different test pulses (PQF, EFT, Surge, etc.) to an EUT in rapid sequence, without re-cabling or re-booting the EUT between tests. This provides enormous flexibility, and can save days of testing time.

- *Three control modes* - Manual, automatic and computer-managed. The manual and automatic modes are provided by system-resident software. The computer-managed mode is available in KeyTek's proprietary Microsoft Windows™ -based test software package.
- *Take Charge*™ - Automatic and computer-managed modes permit manual intervention at any time during a run to modify the test sequence or to perform additional one-time tests.
- *Stored Standards*™ - Software needed to perform testing to dominant pulsed-EMI standards are supplied with the system. There is no more need to study complex standards and write or adapt your own software.
- *Stored Tests* - Complex, custom test routines can be built, stored, modified and retrieved with just a few keystrokes.
- *Diagnostic Data*™ and *FiberLoop*™ - A complete array of both analog and digital measurements can be performed, before and after each test, via FiberSense™ modules connected to user selected points within the EUT and its I/O ports. Measurement results are available at the front panel or at the external computer.
- *Virtual Front Panel*™ - Includes operator-programmable controls.
- *FiberCom*™ - Fiberoptic-isolated RS-232 connection between the ECAT system and an external computer running Microsoft Windows 3.x[2].

Failure Diagnosis

Guessing why or when equipment failed is no longer acceptable. The ECAT system provides two major innovations that combine to provide the equipment designer with an extremely powerful diagnostic tool.

- FiberLoop, a non-intrusive, fiberoptic interconnect system
- Microprocessor-controlled AC mains current monitoring

FiberLoop includes a variety of FiberSense modules that can be placed inside the EUT and connected to the central controller via fiberoptic cable. The modules measure a wide range of digital and analog signals and ambient conditions before, during and after the test. The fiberoptic link eliminates the possibility of spurious interference with test results.

The information produced can almost invariably point the designer to the primary cause of failure, and eliminates most of the educated guesswork that, until now, has been the only alternative.

---

[2] Windows 3.x refers to Microsoft Windows™, Version 3.1 and later.

AC Mains Measurements

Knowing precisely what has happened to EUT power mains current immediately after application of a test can yield new insights concerning failure modes.

Special ECAT options (VI-E455X or VI-E55X) permit the Control Center to monitor the instantaneous, peak and RMS values of the AC supply current to the EUT. Both rms and peak values are determined within one cycle.

This powerful capability can be used to determine if the EUT AC input current drops out a few milliseconds after a test, indicating a blown fuse or breaker. It can also determine whether the AC current increases suddenly following a test, indicating excessive power-follow. The feature is also useful in helping you define AC input current failure in each specific EUT - since 15 A or 30 A circuit breakers cannot really protect EUTs with low power mains input currents.

ECAT Instrument Groups

Surge Testing

The E-Class, Series 500 Surge Simulator provides unprecedented ease, safety, and accuracy in testing surge immunity in computers, communications equipment and other electronics equipment. It generates repeatable, reproducible power line, and I/O line and telecom line surge tests with real waveform integrity, and provides key measurement facilities that eliminate the guesswork in diagnosing failures in the EUT. Table 1 shows the surge test standards supported by the E-Class Series 500 Surge equipment.

For example, when you call up a surge with a 3 kA short circuit current peak, you will get an accurate 3 kA, not 2.5 kA (and not 4 kA either!). This kind of precision surge testing is mandatory in the modern electronics world.

Series 500 Surge Simulator features and options include:

- Full spectrum of available networks. Each delivers true waveform accuracy and reproducibility - together they conform to all mainstream standards
- Fully configurable power line and I/O line couplers
- SurgeWare® - the total application package for controlling the simulator and logging results from an external computer running under Microsoft Windows
- Noise-immune testing
- Accurate and repeatable surge placement - at any phase of the power cycle

Table 1-1. Dominant Surge Standards and Applicable ECAT Modules

TEST STANDARDS	SURGE TYPE			Test Standard PURPOSE AND DESCRIPTION	Plug-in Surge Network
	Power Mains	Telecom	I/O Lines		
IEC 801-5 (draft)	■		■	Requirements for simulating surges on both power and I/O (data and signal) lines.	E501
IEC 801-5 (draft)		■[a]		Requirements for simulating surges on balanced lines from telecom equipment.	E502
ANSI/IEEE C62.41[b] (rev) Standard Waves	■			For "low voltage" power line applications, i.e., below 1 kV AC both indoors and outdoors.[c]	E501 & E503
UL 1449	■			Qualification tests for AC power line protectors.	E501 & E504
FCC Part 68 TELECOM & POWER LINES	■	■		For qualifying telecom equipment: specifies surge test on power and telecom lines.	E505
LSSGR (Bellcore)		■		Surge test requirements for telecom equipment installed in various locations.	E506
CCITT Rec K.12		■		For evaluating gas tube surge arresters.	consult KeyTek
CCITT Rec K.17		■		For qualifying telecom repeaters.	E502
CCITT Rec K.20		■		For qualifying telecom central office equipment.	E502
CCITT Rec K.21		■		For qualifying telecom station (i.e., subscriber) equipment.	E502
CCITT Rec K.22		■		For qualifying within-building telecom equipment.	E501 & E504

[a] The E502 Surge Network provides the most popular 10/700 µs wave with two 25 Ω outputs for true three-terminal surge testing. It also supplies a 0 Ω output for use with multi-line external coupler/decouplers, as well as a 0.5/700 µs wave with all outputs for the most realistic testing.
[b] Formerly IEEE 587.
[c] C62.41 is the de facto test standard.

Power Quality Failure Testing

The KeyTek E-Class Series PQF Power Simulators include the series EP60 Swell, Dip and Interrupt simulators, the EP70 Power/Arb™ simulators and the EP80 Switched/Arb™ simulators. Together, these reproduce power mains voltage swells, dips, ramps, interrupts, notches and harmonics - all with realistic inrush current drive capability in both single phase and three phase applications.

The Series 60 and Series 80 PQF equipment provide repeatable, reproducible power mains voltage swells, dips and interrupts. The Series 70 and Series 80 PQF instruments generate power voltage ramps, superimposed damped oscillations, and superimposed signalling voltages.

The Series 60 and Series 80 units exceed the inrush current drive capability specified in modern PQF standards:[3] 500 A at 240 VAC mains, 250 A at 120 VAC mains into a 1700 µF capacitor; plus rise and fall time requirement of 1 µs to 5 µs into a 100 ohm load.

Series 60 Simulators provide:

- Nine built-in sag and swell percentages of input line voltage ranging from 40% to 150%, to allow realistically complex fault sequences that require switching among three or four (not just two) different levels.
- Two kinds of dropout: short-circuit equipment and open-circuit zero, representing remote (power system) and local (breaker or fuse) failures, respectively.
- Up-voltage switching anywhere, including at powerline peaks, to provide worst-case EUT stress.

Series 70 Simulators provide totally flexible waveforms allowing replication of virtually any powerline fault, especially:

- *Harmonics* due to non-linear and time-variant loads
- *Peak clipping* due to non-power-factor corrected electronic loads
- *Notches and glitches* due to loose connections and defective electronic loads
- *Low frequency damped oscillatory surges* (below 2 kHz) that result from switching of power-factor correction capacitors, ringing in distributed power mains cabling, and signalling voltages.

Series 80 Simulators provide the same waveform capabilities as the Series 70 instrument with the peak inrush current drive capacity of the Series 60 instruments.

---

3. IEC draft Dip/Interrupt standard, IEC 77B (Secr) 97.

All Series PQF units support:

- PQFWare®, the total application package for controlling the simulators and logging results from an external computer running Microsoft Windows 3.x
- Noise-immune testing
- Accurate and repeatable event placement - at any phase of the power cycle
- Total EUT power measurements: RMS current and voltage, true power and power factor, and peak current

Electrical Fast Transient and Burst Testing

The E-Class, Series 400 EFT and Burst simulators generate EFT pulse bursts with the correct exponential waveform and with the correct test pulse durations. The instruments provide complete control over the pulse repetition rate and the pulse frequency within each burst.

Simulator features include:

- Peak pulses to 4.4 kV or to 8 kV depending on model
- Selectable options for pulse frequency within burst: constant, chirp (varies during burst) and random
- Random repetition rate or synchronous with power mains
- Optional output to capacitive clamp for coupling EFT burst to I/O lines
- Fully-interlocked coupling clamps available from KeyTek
- BurstWare, the total application package for controlling the simulators and logging results from an external computer running Microsoft Windows 3.x

The EFT simulators provide test stimuli in conformance with all dominant test standards.[4]

[4] IEC 1000-4-4/D (IEC 801-4) and ANSI/IEEE C62.41 (revised)

The New EMC World - What is it, Why Should You Care?

In this world of proliferating, high-speed digital circuitry, the concept of Electromagnetic Compatibility has evolved from an interesting idea to an essential component of overall product quality.

In general, pulsed EMI disturbances are caused by sparks - both visible and invisible. Sparks range in intensity from lightning bolts (cloud-to-cloud and cloud-to-earth), to normal switch arcing, to the small but potentially devastating electrostatic discharges from fingers to sensitive equipment. The assorted electrical blips and bumps caused by these sparks, many involving very high power or extremely fast rise times, threaten both the well-being and the reliability of modern high-speed, low-voltage circuitry. And they may also affect the very quality of the AC power mains voltage on which virtually all electronic equipment depends.

Product immunity to pulsed EMI is worthwhile, but how important is it, really? The issue of immunity now matters from a purely business standpoint because of the EC92 EMC Directive. In other words, in order to sell electronic products in Europe, meeting ESD, EFT and surge test standards will be mandatory. Companies selling into Europe (almost everyone in the electronics industry) will be unwilling to test to two or more standards, so the European standards will dominate. ECAT is the only total system that can tell you, for sure, whether your products are meeting the pulsed EMI requirements of the EMC Directive and, if they are not, how to fix them.

Chapter 2
System Description

This chapter introduces two typical system configurations and describes the following elements of the instrument in detail:

- Cabinet and Control Center
- Instrument modules for Surge, EFT and PQF testing
- Measurement Capabilities for Surge, EFT and PQF testing
- FiberLoop™

Three System Examples

There are three system illustrations on the pages that follow. They illustrate popular configurations in which the ECAT system can be used and demonstrate the inherent modularity and flexibility of the instrument.

Figure 2-1 shows a basic simulator commonly used for surge testing single phase devices through the power cable. The system consists of a standard single-bay cabinet with the Control Center and Virtual Front Panel. The system is fitted with two instrument modules, an E501 Surge Network and an E551 Coupler/Decoupler.

In the configuration shown, the instrument generates the standards-compliant[1] Combination Wave[2] at all voltage levels required, and couples that surge to the equipment under test either through the power cable or directly to a selected connector, circuit or component of the EUT.

---

1. International Electrotechnical Commission (IEC) 801-5/D and American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE) C62.41 (1991).

2. The Combination Wave is a surge with 1.2/50 µs open circuit voltage, 8/20 µs short circuit current and 2 Ω effective output impedance (i.e., 6 kV/3 kA., 4 kV/2 kA, etc.). It was pioneered as the KeyTek Bi-Wave in 1979.

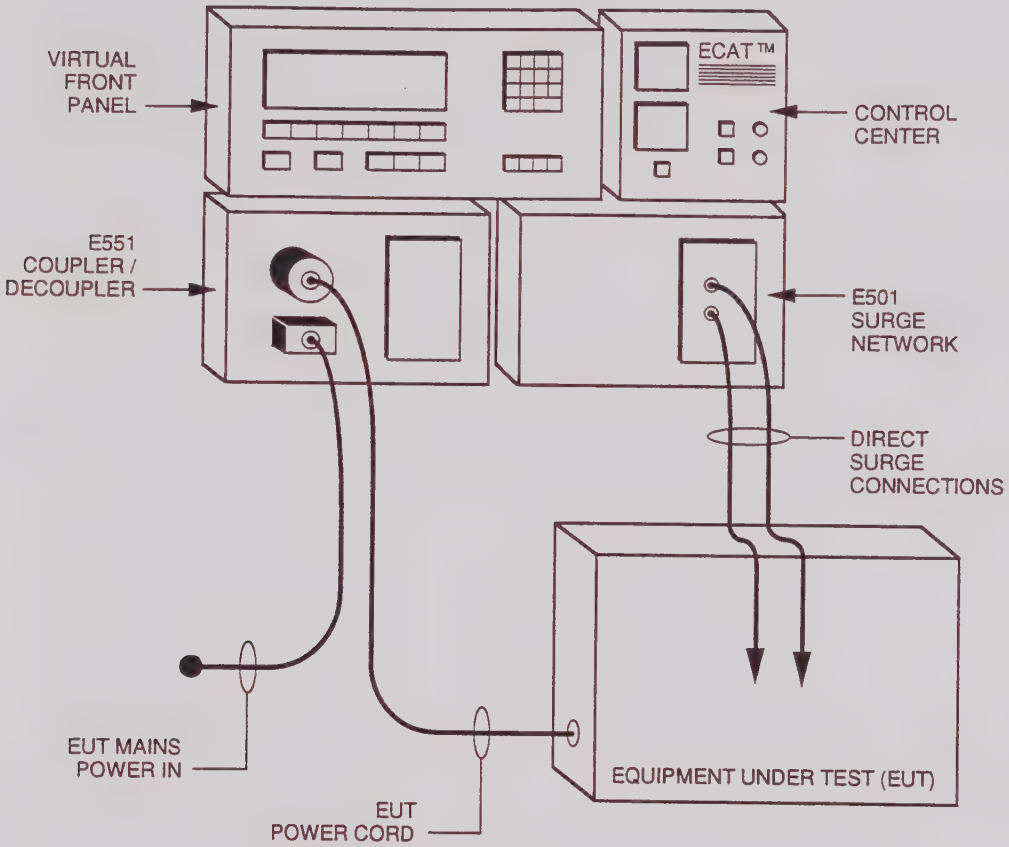

Figure 2-1. Basic ECAT Surge Simulator in a Single-bay Cabinet

Figure 2-2 illustrates a system that combines Surge and EFT testing. The system consists of a standard two-bay cabinet with the Control Center and Virtual Front Panel. The system is fitted with three instrument modules: the E501 Surge Network, the E411 EFT/Burst source and the E4551 EFT/Surge Coupler/decoupler.

In the configuration shown, the instrument generates the Combination Wave and various EFT waveforms or bursts. The instrument couples the surge to the equipment under test either through the power cable or directly to a selected connector, circuit or component on the EUT. It couples the EFT signal onto the power cable of the EUT or onto data lines using a standard EFT coupling clamp (not shown).

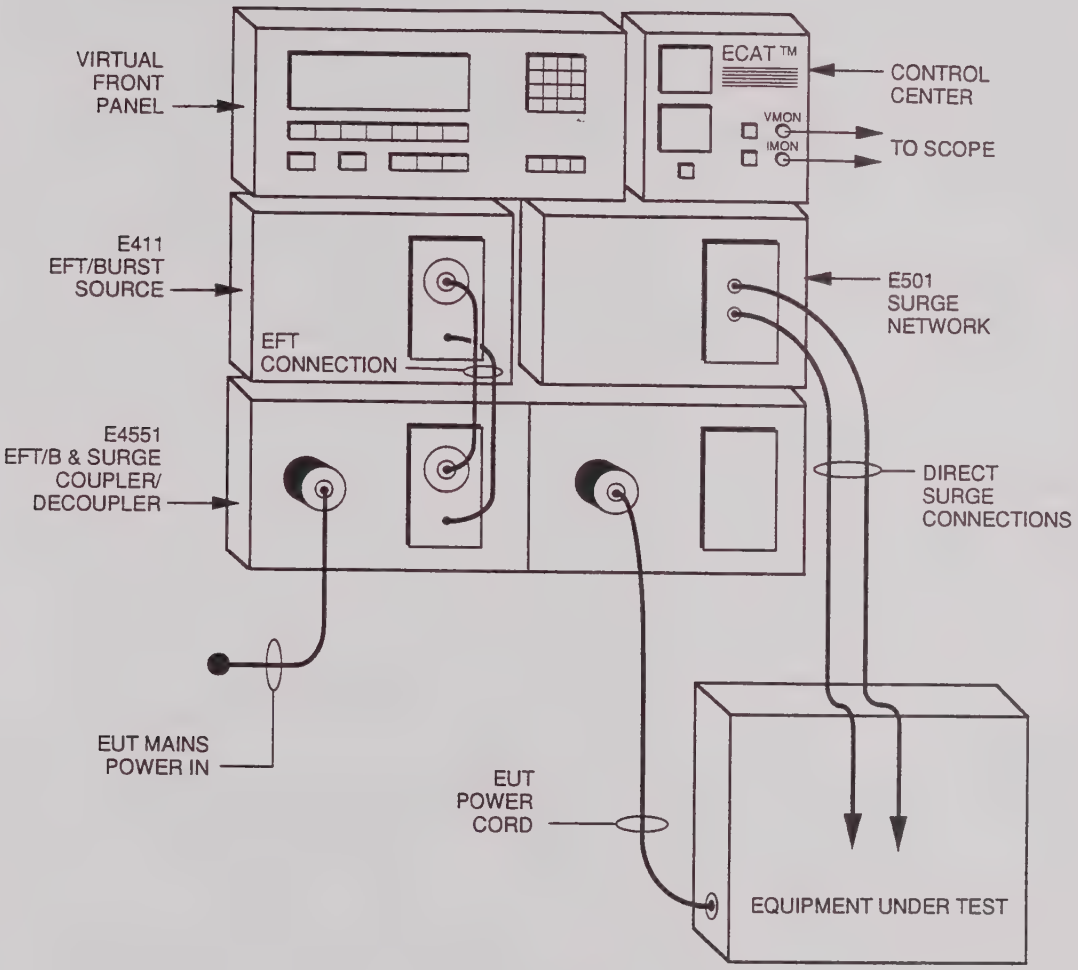

Figure 2-2. Combined Surge and EFT Simulator in a Two-bay Cabinet

Figure 2-3 shows a configuration that is appropriate for performing Surge, PQF and EFT testing on single phase telecommunications equipment. The system consists of a standard four-bay cabinet with Control Center and includes six instrument modules: the E501 and E505 Surge Networks, the E411 EFT/Burst Source, the EP61Power Swell/Dip/Interrupt Source, the E4551 EFT/Surge Coupler/decoupler and the E571 RS-232 Coupler/decoupler. This system includes the total voltage and current monitoring option and FiberCom, which allows it to operate under the control of

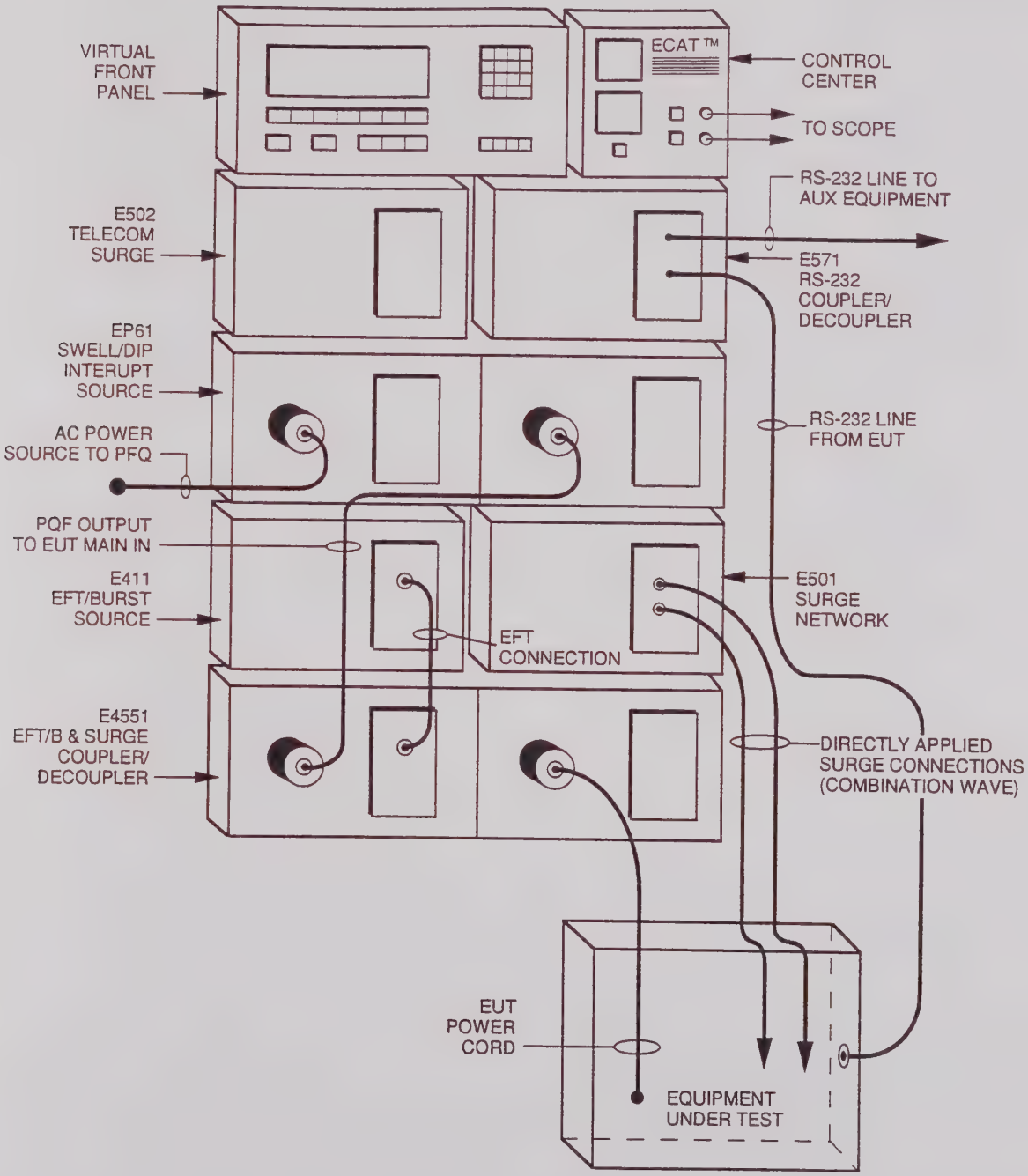

Figure 2-3. Multi-function Surge plus EFT and PQF in a Four-bay Cabinet

SurgeWare, PQFWare and BurstWare running under Microsoft Windows 3.x[3] on an external PC. In this configuration, the instrument generates the standards-compliant Telecom Line Surge,[4] and the Combination Wave previously described. In addition, it generates the EFT/Burst waveforms and simulates PQF events. It couples the surge waveforms to the equipment under test through the power cable, through the RS-232 cable, or directly to a selected connector, circuit or component on the EUT. It couples the EFT waveform or burst to the EUT through the power cable or onto data lines using a standard EFT coupling clamp (not shown). It applies the PQF events to the EUT through the power cable.

The systems in Figures 2-2 and 2-3 illustrate single-plug test setups that allow several kinds of tests to be performed on the EUT without re-booting the equipment.

Control Center and Cabinet

The basic cabinet of every system includes a Control Center and one or more equipment bays.

The Control Center is located at the top right-hand corner of the instrument. It includes a Stop Switch for emergency system shutdown, the System Power switch, an EUT Mains control, and connectors for the FiberLoop option.

An equipment bay accommodates either two half-width modules or one full-width module. Systems with one or two bays are bench top systems, and systems with three or four bays are floor-standing on wheels.

Instrument modules slide into the cabinet and are secured in place with a locking screw which is accessible from the front. They can be added and removed at any time. Additional bays can be added in the field. The maximum configuration is four bays per control center.

Note

There must be either an instrument module or a Model E000 Blank Module (cover) installed in every half-bay to close the system interlocks. Otherwise the instrument will not operate.

3. Windows 3.x refers to Microsoft Windows™, Version 3.1 and later.
4. The Telecom/Data Surge is a 10/700 µs open circuit voltage wave through two 25 Ω output resistors; it also supports a 0.5/700 µs wave.

Instrument Modules

Instrument modules include signal sources and coupler/decouplers. The source modules produce high energy surges, EFT bursts and PQF events. Coupler/decouplers are used to inject source signals into the AC power source for equipment under test without injecting the same pulse on the AC main source.

There are a number of features common to all modules:

- Each module has an Active Module indicator that goes on when the instrument is selected from the Virtual Front Panel or from the Microsoft Windows application software.
- Each module has a Voltage Present light that goes on when high voltage or AC mains voltage is present in the module or at the output connectors.
- All high voltage connections to a module are made via connectors located behind a clear plastic door that is electrically interlocked to the system. If the door opens, the high voltage system in the module is disabled and any accumulated charge is instantly dissipated internally.

Surge Networks and Coupler/Decouplers

Surge Networks

Surge networks include surge networks and coupler/decouplers.

Surge networks generate a high energy pulse of precise shape, phase, and amplitude through a specified output impedance. The ECAT system includes a variety of surge networks - each produces waveforms that meet the testing specifications of one or more domestic or international standards. Depending on the type of network and installed options, output selections include:

- Open circuit voltage level and range
- Short circuit current range
- Pulse rise and fall times
- Polarity
- Output impedance
- Voltage and current measurement sources
- Direct output or output through a surge coupler/decoupler

The surge output from a network is available at output terminals on the module, or it can be internally routed by the ECAT system to a coupler/decoupler located in another bay. Figure 2-4 is a block diagram of a surge network and a coupler/decoupler.

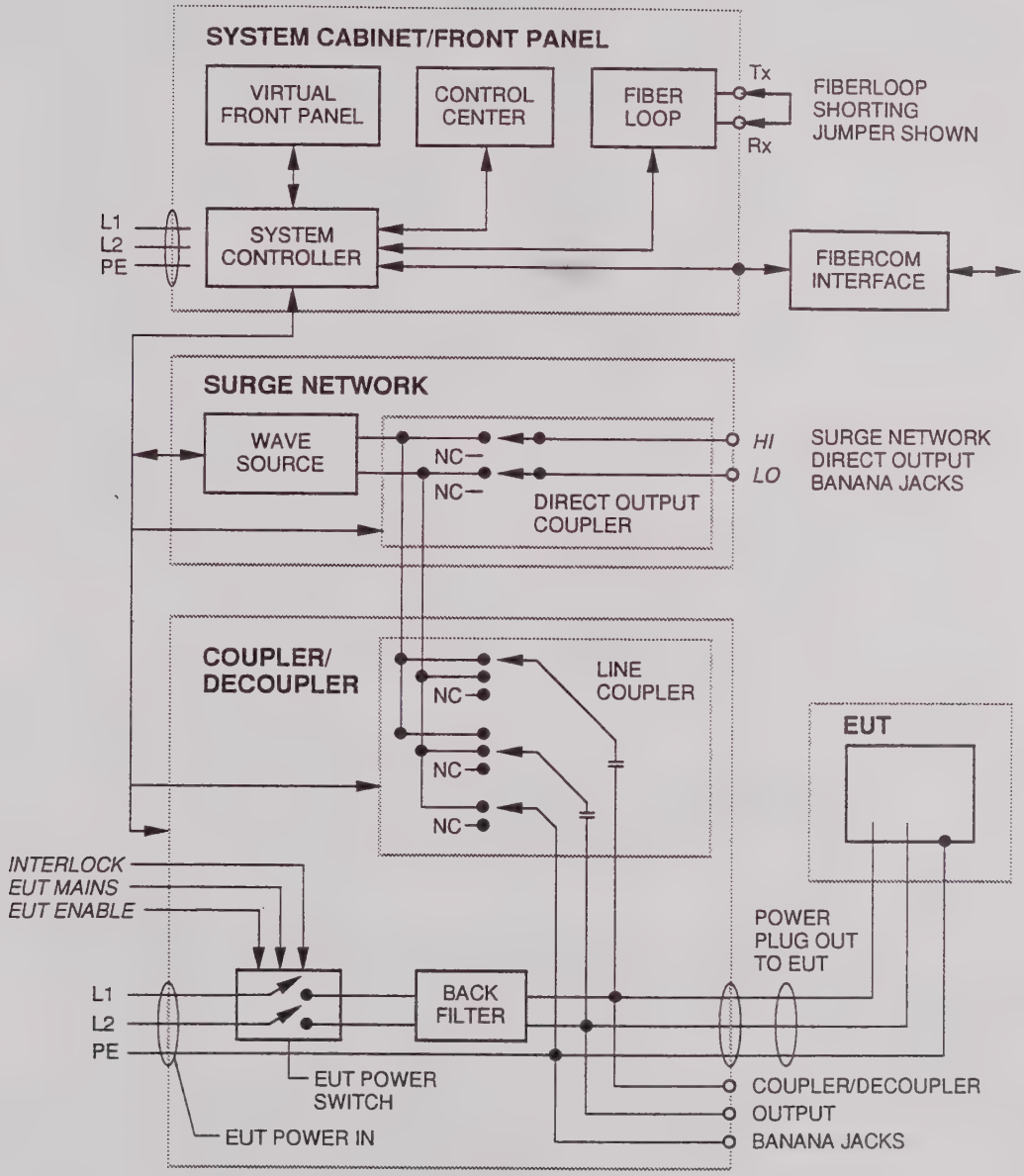

Figure 2-4. Block Diagram, Surge Network and Coupler/Decoupler

Most surge networks are half-width modules. In most cases, a surge module can be installed in any position in the ECAT cabinet.

A brief listing of standard capabilities and options for a number of surge networks is given in Table 2-1. The table also lists the testing standards appropriate for the network.

Table 2-1. Surge Networks, Description and Applicable Test Standards

Model Number	Description	Standards
E501	Combination Wave: 1.2/50 µs OCV, 8/20 µs SCI to 6 kV and 3 kA. Includes software-selectable 10 Ω series output resistor. Option VI-E501 provides surge V and I monitoring plus peak detection.	IEC 801-5 ANSI/IEEE C62.41 UL1449 CCITT Rec K.22
E502	Telecom Wave: 10/700 µs OCV with two 25 Ω outputs for true three-terminal surging of lines connected between instrumentation and telecom equipment. Also includes a 0 Ω output for use with external coupler/decouplers for multi-line systems. Additional 0.5/700 µs OCV wave also supplied for more realistic simulation of telecom surge stress. Option VI-E502 provides surge V and I monitoring and peak detection.	IEC 801-5 CCITT Rec K.17 CCITT Rec K.20 CCITT Rec K.21
E503	Ring Wave: 100 kHz 0.5 µs rise time OCV decaying exponential, with 6 kV maximum. Selectable 200 A or 500 A SCI at 6 kV. Option VI-E503 provides surge V and I monitoring and peak detection.	ANSI/IEEE C62.41
E504	Combination Wave: Provides true 1.2/50 µs OCV, 8/20 µs SCI Combination Wave with maximum currents of 500 A and 750 A for duty-cycle surge testing. Option VI-E504 provides surge V and I monitoring and peak detection.	UL 1449 CCITT Rec K.22

Table 2-1. Surge Networks, Description and Applicable Test Standards *continued*

Model Number	Description	Standards
E505	Telecom Wave: <10 x > 160 µs 0-1.5 kV, 200 A max. Not coupled to power line. <10 x > 560 µs 0-800 V, 100 A max. Not coupled to power line. <10 x > 560 µs 0-800 V, 200 A max. Not coupled to power line. < 2 x > 10 µs 0-2.5 kV, 1 kA max. Option VI-E505 provides surge V and I monitoring and peak detection.	FCC Part 68 Telecom FCC Part 68 Power Line
E506	Telecom Wave: <2 x > 10 µs SCI 0- 800 V 100 A max. per side. <2 x > 10 µs SCI 0-1.5 kV 100 A max. per side. <2 x > 10 µs SCI 0-2.5 kV 500 A max. per side. <2 x > 10 µs SCI 0-5.0 kV 500 A max. per side. Option VI-E506 provides surge V and I monitoring and peak detection.	Bellcore LSSGR TA-NWT-1089
E510	Extended Combination Wave: 1.2/50 µs OCV, 0-10 kV 8/20 µs SCI to 5 kA. Includes software-selectable 10 Ω series output resistor. Option VI-E510 provides surge V and I monitoring and peak detection.	IEC 801-5/D ANSI/IEEE C62.41
E511	High Current Combination Wave: 1.2/50 µs OCV, 8/20 µs SCI to 6 kV and 5 kA Option VI-E511 provides surge V and I monitoring and peak detection.	

Coupler/Decouplers

Surge coupler/decouplers provide a method of superimposing the output of a surge network onto the AC power line or data lines of an EUT in a manner that protects other equipment not being tested from the surge. Surge coupler/decouplers are available in the following configurations:

- AC mains coupler/decoupler, for surge only
- AC mains coupler/decoupler, for surge and EFT
- I/O lines coupler/decoupler

Mains Coupler/Decoupler

The AC mains coupler/decoupler allows selective coupling to individual or multiple conductors of the power line. Single phase and three phase units are available at various current ratings. Some modules can couple both surge and EFT waveforms onto the power lines, others are used for surge coupling alone. All units derive a phase timing reference that allows triggering the output pulse at a precise phase location on the power cycle. Depending on the type of coupler/decoupler and the options, output selections on the AC mains units include:

- Line selection (phases, neutral, PE)
- Phase reference (derived from L1)
- Current and voltage measurement source

The AC mains coupler/decoupler has an AC input connector and an output connector. The input connector is either an IEC 320 for a single phase coupler/decoupler, or a Hubbell twist-lock connector for a three phase unit. A power cable with a country specific connector is provided for attaching to the AC mains. The AC output connector of the coupler/decoupler is also configured for the country of installation.

Single phase surge-only coupler/decouplers are half-width modules. Three phase and combined Surge and EFT units are full-width modules. In most cases, a coupler/decoupler can be installed in any position in the ECAT cabinet. For EFT testing, however, the coupler/decoupler should be installed in the lowest bay.

A brief listing of standard capabilities and options for a number of coupler/decouplers is given in Table 2-2.

I/O Line Coupler/Decoupler

The I/O lines coupler/decouplers introduce surge waveforms onto a variety of I/O lines, including RS-232 cables. The couplers employ a bridge-mounted silicon avalanche protector to achieve extremely low capacitance coupling that won't load the I/O line like a conventional coupling capacitor or transformer.

I/O lines coupler/decouplers are half-width modules, and can be installed in any position in the ECAT cabinet.

A brief listing of standard capabilities and options for I/O lines coupler/decouplers is given in Table 2-2.

Table 2-2. Coupler/Decoupler Features and Options

Model Number	Description	Size
E551	Single Phase: For AC mains up to 250 V, 15 A (US) or 16 A (Int'l). Accepts all surge network outputs, includes all coupling modes selectable from VFP or SurgeWare without interrupting EUT power or rebooting the EUT. Provides surge voltage monitoring and peak detection across any two manually-selected lines. Provides surge current monitoring and peak detection in L1 or L2, selectable from VFP or SurgeWare. Option VI-E551 extends V and I monitor to all three lines.	1/2 Wide
E552	Single Phase: For AC mains up to 277 V, 30 A (US) or 250 V, 32 A (International). Identical function to E-551 above. Extended V and I monitor option is VI-E552.	Full Wide
E553	Three Phase: For AC mains up to 277/480 V, 20 A (US) or 240/415 V, 16 A (International). Identical function to E-551 above. Extended V and I monitor option is VI-E553.	Full Wide
E554	Three Phase: For AC mains up to 277/480 V, 30 A (US) or 240/415 V, 32 A (International). Identical function to E-551 above. Extended V and I monitor option is VI-E554.	Full Wide
E571	RS-232: For surge testing RS-232 cables and circuitry. Exceeds the requirements of I/O line couplers shown in latest draft of IEC 801-5. Coupling via bridge-mounted silicon avalanche protector, an extremely low capacitance coupling that won't load the RS-232 signals as does the conventional coupling capacitor or transformer.	1/2 Wide
E572	Higher Speed I/O: For surge testing up to two high speed paired lines such as Ethernet links, via a 42 Ω effective source impedance[a], per IEC 801-5. Features low capacitance coupling to minimize loading on the I/O lines and provides built-in surge protection and decoupling to protect auxiliary equipment connected to the I/O lines.	1/2 Wide
E573	Balanced Telecom Line Coupler/Decoupler: For surge testing up to two balanced telecom lines per IEC 801-5. Features low capacitance coupling to minimize loading on the I/O lines and provides built-in surge protection and decoupling to protect auxiliary equipment connected to the I/O lines.	1/2 Wide

[a] Per IEC 801-5, I/O line tests with this source impedance results in shortened duration of the surge waveform.

PQF Simulators

PQF simulators produce power mains voltage dips, interrupts, notches and harmonics. The ECAT system includes a variety of PQF simulators which meet the testing specifications of existing and planned international standards and industry-wide de facto standards. The PQF simulators provide realistically low source impedance, which allows high inrush current peaks, to over 500 A with appropriate rise and fall times. Depending on the type of network and installed options, output selections include:

- Voltage level (up to nine preset percentages of input line voltage, ranging from 40% to 150%)
- Start phase and end phase for each level
- Up to twelve transitions programmable within a single AC power cycle (360 degrees)
- Duration (in degrees, cycles, seconds, etc.) of each voltage level (minimum duration is approximately 1 to 2 degrees)
- Multiple voltage levels allowed in a single test sequence (up to three levels in addition to 100% level)
- Up to 300 steps per sequence
- Peak current limit
- RMS current limit
- Two kinds of dropout simulation: short circuit and open circuit
- Internal qualification of AC mains inrush capacity

The PQF output is available at standard AC mains connectors on the front of the simulator module. Many optional connectors are available on request.

Figure 2-5 shows a block diagram of the PQF simulator.

PQF simulators are full-width modules. In most cases, a PQF network can be installed in any position in the ECAT cabinet.

A brief listing of standard capabilities and options for a number of PQF simulators is given in Table 2-3. The table also lists the testing standards for which the device is appropriate.

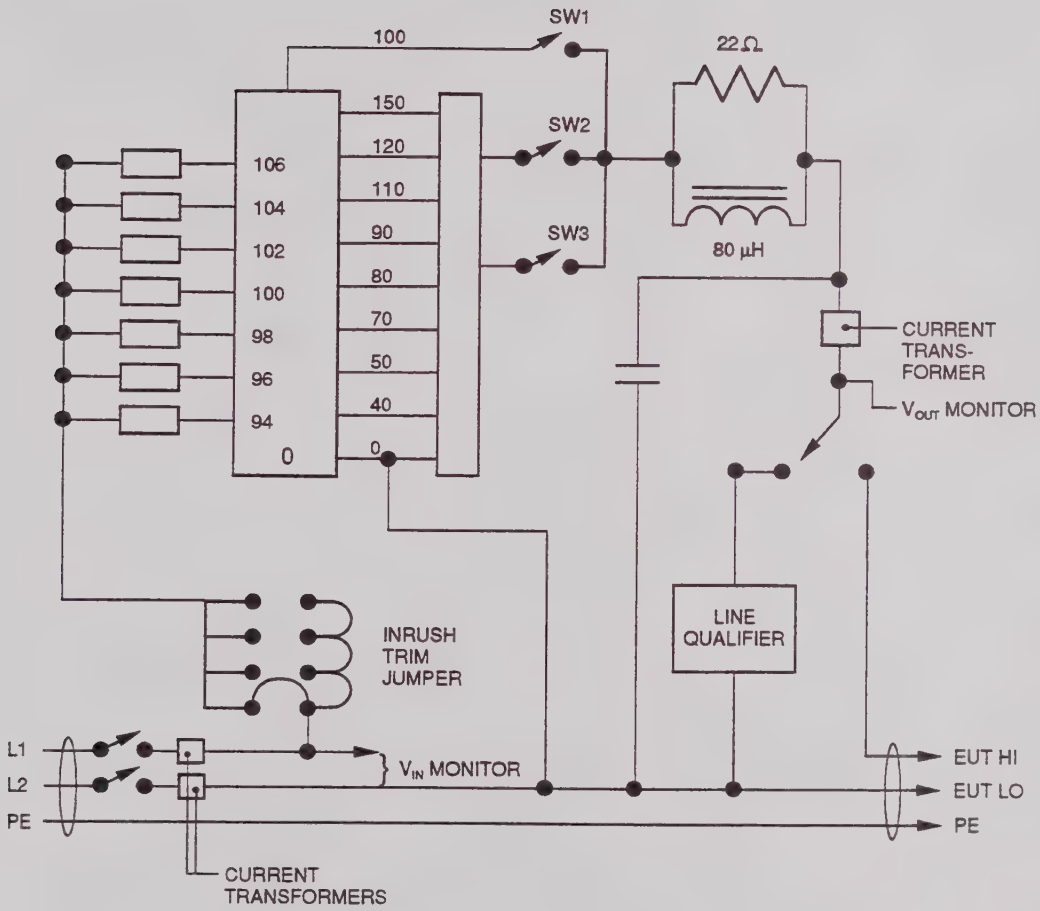

Figure 2-5. Block Diagram, PQF Simulator

Table 2-3. PQF Capabilities and Options

To Simulate	Resulting From	Appropriate PQF Simulator			
		Series 60	Series 70	Series 80	Series 60+70
Turn on inrush[a]	Power up	■		■	■
Swells, dips, interrupts, between any voltage and 100% of mains voltage	Fault-clearing, recloser operation, power-feeder switching.[b]	■		■	■
Swells, dips, interrupts, between any of two mains voltage steps. Available steps include: 0%[c], 40%, 50%, 70%, 80%, 90%, 100%, 110%, 120%, 150%.	Extreme, multiple-voltage, repetitive fault scenarios.[a]	■			■
Harmonics, including peak clipping	Non-linear loads, including non-power-factor corrected and switched electronic loads		■	■	■
Slowly-varying ramps	Ramping power restoration.		■	■	■
Notches, glitches, other fractional-cycle aberrations	Loose connections, electronic loads.	■		■	■
Low frequency damped oscillations (less than 2 kHz).	Switching of power factor correction capacitors, resonances in cabling within structures.		■	■	■

[a] Per IEC 77B (Secr) 97, turn on current into a 1700 µF capacitor must exceed 500 A at 240 V, or 250 A at 120 V.
[b] With realistic peak inrush current drive capability, rise and fall times.
[c] 0% may be short circuit or open circuit.

EFT Sources and Coupler/Decouplers

EFT sources produce a burst or a series of bursts of very fast rise time voltage pulses.[5] This simulates the electrical interference often associated with the opening of a switch or relay contacts. The ECAT system includes a variety of EFT sources - each produces waveforms that meet the testing specifications of one or more domestic or international standards. Depending on the type of device and installed options, output selections include:

- Pulse voltage level
- Frequency of pulses in a burst (including chirp and random)
- Duration of pulse burst (synchronous or asynchronous to power mains)
- Period of repeating bursts
- Polarity of the output pulse
- Coupling options
- Phase reference triggering when coupler/decoupler is used (derived from L1)

The output from an EFT source is available at output terminals on the module; some units include an integral coupler/decoupler. In addition, the EFT output can be cabled to a combined EFT/Surge coupler/decoupler located elsewhere in the ECAT cabinet.

Figure 2-6 shows a block diagram of the EFT/Burst source and a coupler/decoupler.

Simple EFT sources, and most sources that include a single-phase coupler/decoupler are half-width modules. Three phase EFT coupler/decouplers, 8 kV EFT sources, 30 A single phase EFT and the 30 A EFT/Surge units require a full bay.

An EFT/Surge coupler/decoupler must be located in a bay vertically adjacent to, preferably below, its EFT source. To maintain the standards-recommended distance from the EFT source to the ground reference plane, the EFT modules should be located at the bottom of the ECAT cabinet.

A brief listing of standard capabilities and options for a number of EFT sources is given in Table 2-4. The table also lists the testing standards for which the device is appropriate.

[5] Voltage pulse with 5 ns rise time and 50 ns exponential decay measured into 50 Ω termination, per IEC 801-4 and ANSI/IEEE C62.41-1991

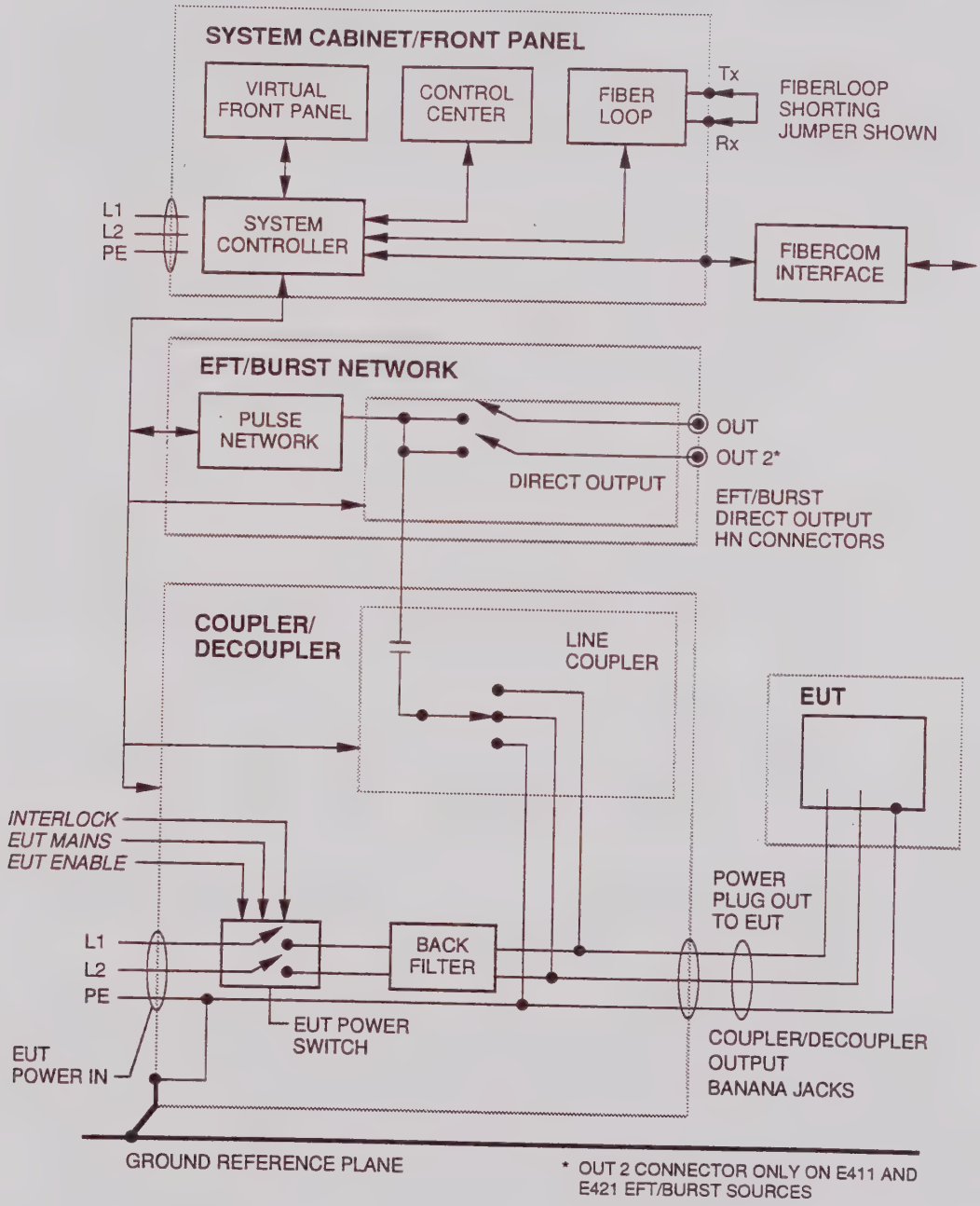

Figure 2-6. Block Diagram, EFT/Burst Source and Coupler/Decoupler

Table 2-4. EFT/B Modules, Capabilities and Options

Model	Peak Voltage	Coupler/decoupler Included
411	4.4 kV	No
412	4.4 kV	15/16 A, 250 V, single phase
421	8 kV	No
422	8 kV	15/16 A, 250 V, single phase
423	4.4 kV	16/20 A, 277/480 V[a], three phase
424	4.4 kV	30/32 A, 277/480 V[a], three phase
433	8 kV	16/20 A, 277/480 V[a], three phase
434	8 kV	30/32 A, 277/480 V[a], three phase

[a] Optionally can be increased to 347/600 V.

Measurement Capability

The ECAT instrument can report peak voltage and current at the load after each test, and provides isolated scope outputs for monitoring load voltage and current during a test.

The peak detectors capture both positive and negative peak levels and report the results via the front panel or an external computer. Peaks are measured and recorded for one selected current and voltage measurement source.

The voltage and current monitor outputs are single-ended signals that are scaled to levels appropriate for oscilloscopes and other transient waveform recording devices. Monitor inputs are derived from current and voltage sources located in the instrument modules.

There may be several measurement sources installed in a system, but only one current source and one voltage source are active at a time. Inputs are selected using the control panel or remote computer and can be changed for each individual test.

Figure 2-7 is a block diagram of the measurement subsystem showing a surge network and a single phase power line coupler/decoupler, both with full measurement capability.

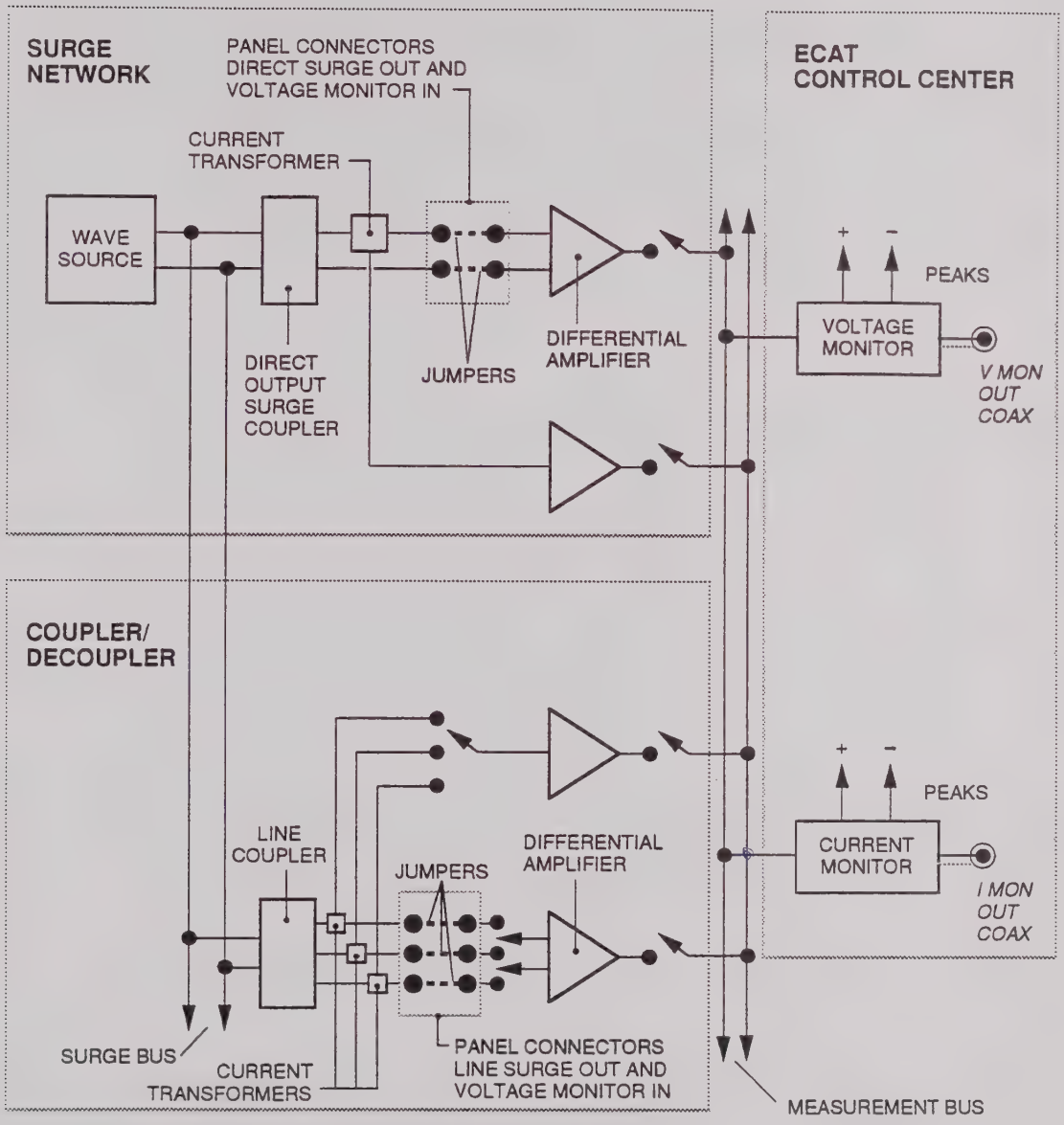

Figure 2-7. Surge Voltage and Current Monitors and Peak Detectors

Surge Network Measurement Options

Surge network options allow measurement of surge current and voltage at the terminals of the surge network. Systems with surge networks in the basic configuration generally monitor voltage and current via the coupler/decoupler.

Current monitor inputs are taken from current transformers installed in selected output circuits within a module. Depending on the installed options, a module may have as many as five current sources. The current monitor inputs in coupler/decouplers measure only load current and ignore back-filter surge currents.

The voltage monitor input is differential and is derived from two voltage input connectors located on the front of a module. The voltage monitor inputs must be externally wired to the circuit to be measured.

Depending on the installed measurement option, there may be as many as five voltage monitor input connectors on a surge module, thereby allowing several permutations to be set up. However, only one pair can be in use at a time.

In most cases, voltage monitor inputs are jumpered directly to the surge outputs of the module, which are located at adjacent connectors. The inputs can be arranged in any fashion and may also be tied to an external circuit, like the EUT, using suitable wiring.[6]

Surge networks in the extended configuration have one current transformer in each Hi output line and have a voltage input connection for each available surge output line. Some networks provide other outputs in addition to surge Hi and Lo. This allows voltage to be monitored between any two of the outputs provided.

The ECAT System measures both the positive and negative peaks of the surge voltage and current. These values are available via the Virtual Front Panel and via SurgeWare software running under Microsoft Windows on an external computer.

6. The voltage measurement must be made differentially. Use wire of suitable insulation rating. Make the shortest possible connection to the external circuit, with lines of equal length. Run both measurement lines together and avoid loops in the path.

PQF Measurement Options

The PQF modules allow monitoring of selected[7] voltage and current levels via the V Mon and I Mon output connectors of the ECAT Control Center.

The voltage monitor point is selectable between input or at the output of the simulator. The input and output monitors are L1 vs. L2. Current monitoring is provided by a current transformer inserted in the PQF simulator output L1.

The ECAT system measures peak and RMS voltage and current. These values are available at the Virtual Front Panel and to the PQF control software running under Windows 3.x on an external computer.

EFT Measurement Options

An EFT waveform (voltage) monitor, intended for driving an oscilloscope, is available at the BNC connector of EFT/Burst modules. Because of the high frequency of EFT waveforms, they are not monitored at the ECAT system Control Center or available at the Control Center VMon or IMon outputs.

Coupler/Decoupler Measurement Options

Surge coupler/decouplers in the standard configuration provide a single pair of voltage monitoring inputs that may be manually jumpered across any two lines. The standard configuration of current transformers are:

- Single phase: Two current transformers, one each on L1 and L2
- Three phase: Three current transformers, one each on L1, L2, and L3

Surge coupler/decouplers in the extended configuration have a voltage monitoring input for each line including neutral and PE. There are current transformers on all lines, including neutral and PE, which provide the following measurement sources:

- Single phase: Three inputs, one each on L1, L2, PE
- Three phase: Five inputs, one each on L1, L2, L3, N, and PE

[7] Select between input and output voltage, plus inrush or output or neutral current.

FiberLoop

The FiberLoop option extends the system interlocks to include doors or gates into the test area, as well as smoke alarms, panic buttons and other monitors. It is also used for remote monitoring at the EUT and a variety of other functions.

Figure 2-8 shows an example of a FiberLoop setup that provides interlocks plus voltage and RS-232 monitoring of a small device being surge tested.

Installation and operation is described in a separate manual that is supplied with the FiberLoop option.

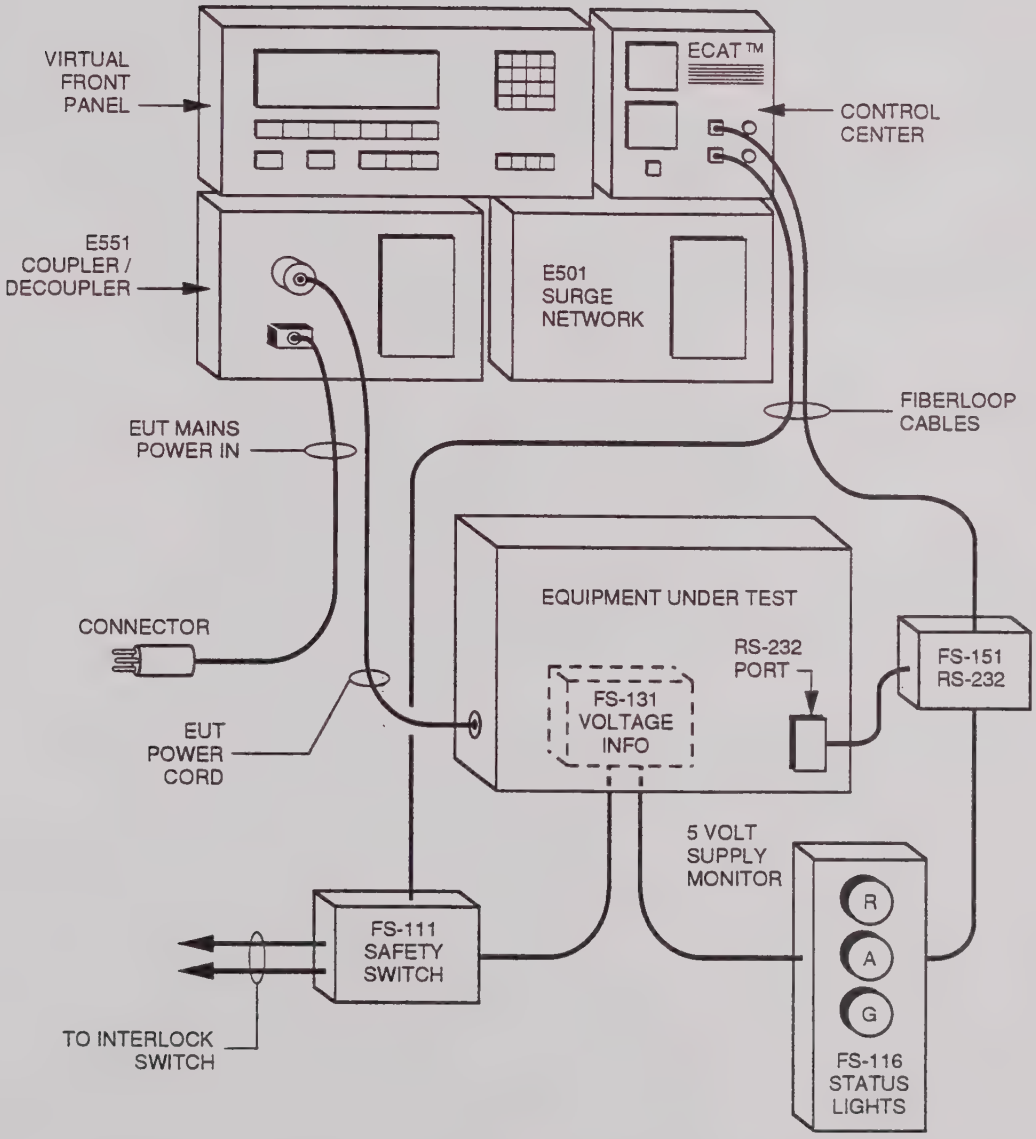

Figure 2-8. FiberLoop, with Interlocks, and Voltage and RS-232 Monitors

Chapter 3
Installing the ECAT System

Correct installation is key to safe and effective use of this instrument. Improper installation can create a dangerous and unnecessary hazard to personnel and other equipment in the facility. Common sources of trouble include:

- Inadequate source of AC power
- Improper wiring and grounding of all test and measurement equipment
- Inadequate physical barriers and interlocks surrounding the test area
- Improper environment relative to humidity and ventilation
- Improper removal, handling or installation of the ECAT instrument modules

Ensure that the installation meets the specifications of the National Electrical Code (ANSI/NFPA 70-1987) and complies with the National Electrical Safety Code (ANSI C2-1987).

Make sure all safety concerns are properly addressed before the equipment is installed. Follow all guidelines given below during installation. Check that all safety issues have been addressed before the equipment is powered up.

Pulsed EMI testing, particularly surge and PQF testing, can be inherently hazardous. The importance of conducting such tests in a prudent manner cannot be overemphasized. Safeguarding personnel is the prime consideration. The following documents contain important information about safety issues pertaining to surge testing:

- ANSI/IEEE C62.41-1991 - IEEE Guide for Surge Voltages in Low-Voltage AC Power Circuits[1]
- ANSI/IEEE C62.45-1987 - IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits
- IEC Pub 664-1980 - Insulation Co-ordination within Low-Voltage Systems, Including Clearances and Creepage Distances for Equipment (including IEC Pub 664A-1981)[2]

Test Area Considerations and Site Preparation

Conduct pulsed EMI testing under sound laboratory conditions. Verify the following:

- No condensing humidity or standing water on the floor or work surfaces
- No significant dust or other contaminants
- Clear and unobstructed vision
- Adequate ventilation, including ventilating hoods and blowers to remove gases
- Nonflammable walls and floors
- Barriers surrounding the EUT to contain exploding parts and flames
- Appropriate fire extinguishers for electrical and chemical fires.

Warning
DO NOT USE WATER TO EXTINGUISH AN ELECTRICAL FIRE.

- No flammable materials or debris inside the test area. The area must be well marked, preferably by physical barriers
- Keep unauthorized personnel out of the area during testing

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1. ANSI/IEEE publications can be obtained from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018 or from the Institute of Electrical and Electronics Engineers, Service Center, Piscataway, NJ 08854.
2. IEC Publications are available in the USA from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018.

Safety Barriers, Interlocks

Pulsed-EMI testing is best done in an area dedicated solely to that purpose. Clearly mark the boundaries of the area. Where possible, fence in the area and install electrical interlocks on all entrances so that testing is shutdown if personnel enter the area.[3] Ground all fences and barriers to the building protective earth (PE) conductor.

There is the possibility that the surge may flash over to circuits or metal objects not directly under test, and that components in the equipment being tested may explode or ignite under the stress of the surge test. Whenever possible, enclose the equipment under test within a fireproof and explosion-proof barrier having insulation capable of withstanding at least twice the maximum surge voltage.

Never allow direct line-of-site view of components that may explode or ignite. If visual observation is required, use a robust transparent barrier of suitable thickness for protection.

Pulsed-EMI testing should only be carried out by fully trained personnel who are informed of the hazards of such testing, and who have full control over all of the test equipment in the area.

Note

While the possibility of component destruction is less of a concern during EFT/Burst testing, it should not be ignored.

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[3] The KeyTek FiberLoop option affords an excellent method for interlocking the area entrances and the equipment.

EUT Power

The AC power source for the EUT must have adequate capacity for full power-follow in the event that testing causes an equipment failure. Using a supply without sufficient capacity may result in a failure being masked. Acceptable power sources include:

- A dedicated branch circuit
- The dedicated output of a motor-generator (MG) set
- The output of a properly installed isolation transformer

Note
A solid-state regulated line source such as an uninterruptable power supply (UPS) or a power frequency amplifier will generally not have the instantaneous capacity or full power-follow, and therefore should not be used as the AC power source for any equipment being tested.

Protect the AC supply for the EUT with a suitable circuit breaker located in the test area. This breaker should have a much lower rating than any other circuit breaker installed upstream in the line ensuring that the breaker in the test area trips first during an over-current condition.

It is necessary to power an EUT through a coupler/decoupler even when surge or EFT bursts are not being applied to the unit through the power cord. Flashover from the connections being tested to the AC power connections of an EUT may occur during a surge test. Moreover, the use of a coupler/decoupler affords an extra measure of safety by interlocking an EUT from powering up except under the explicit control of the test operator.

Under all circumstances, test and verify the integrity of the protective earth (PE) conductor supplied to the Test AC input connector and to the system power connector. Confirm they are wired in strict accordance with local codes. The EUT PE connection is insulated from the system chassis ground, therefore it is mandatory that the integrity of both PE connections be verified. Be sure that all equipment is properly connected to PE.

If the AC source is derived from an isolation transformer or from an MG set, have a qualified electrician test and verify that neutral and PE are properly reestablished at the derived source, as shown in Figure 3-1. This must be done both for single and three-phase configurations. If the wiring is in doubt, do not use it.

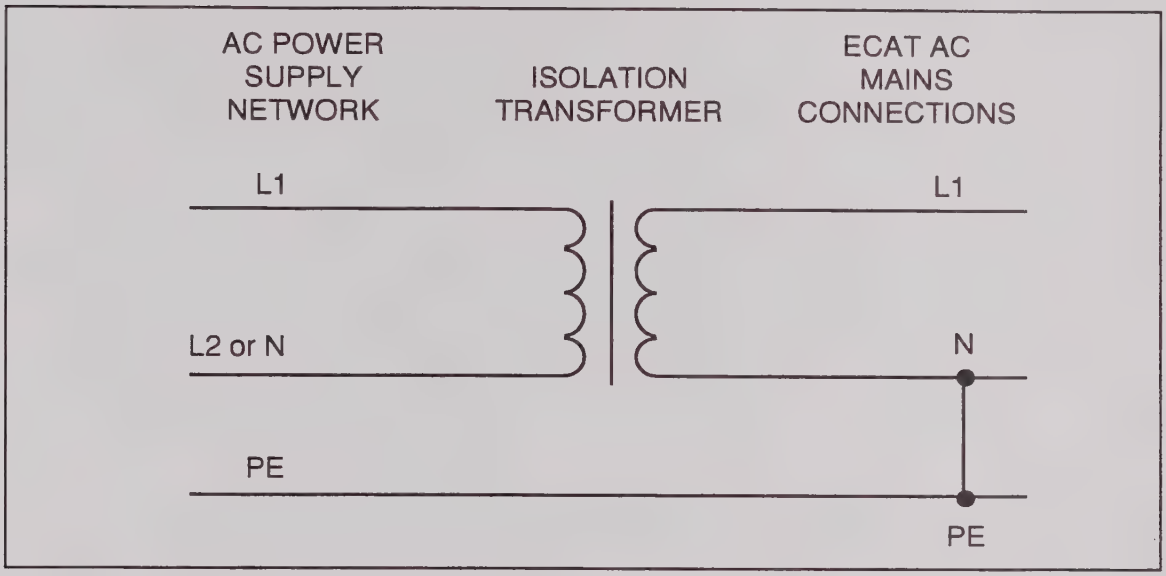

Figure 3-1. Reestablishing Neutral at an Isolation Transformer (Also applies to three phase applications)

Special Considerations for EFT/Burst Testing

EFT/Burst testing involves the use of very high frequency pulses. For this reason the testing standards specify the use of a ground reference plane in the area where EFT/Burst testing is performed. In addition, the standards specify the minimum and maximum spacings among the various equipment present in the test area.

Ground Reference Plane and Equipment Spacing

The floor of the test area is to be covered with copper or aluminum with a minimum thickness of 0.01 inch[4], which must be bonded to building Protective Earth (PE) ground. In addition, the cabinet of the ECAT system must be directly tied to the ground reference plane. Provision for a mounting bracket is made on the rear of the equipment and the bracket and screws are provided. For the benchtop system the grounding bracket is KeyTek Model CGB-1; for the floor-standing system, the bracket is KeyTek Model CGB-2.

Figure 3-2 shows the EFT Capacitive Coupling Clamp, and the minimum spacing required between the clamp and the equipment in the test area.

Figures 3-3a and 3-3b show the recommended configurations of equipment in the test area.

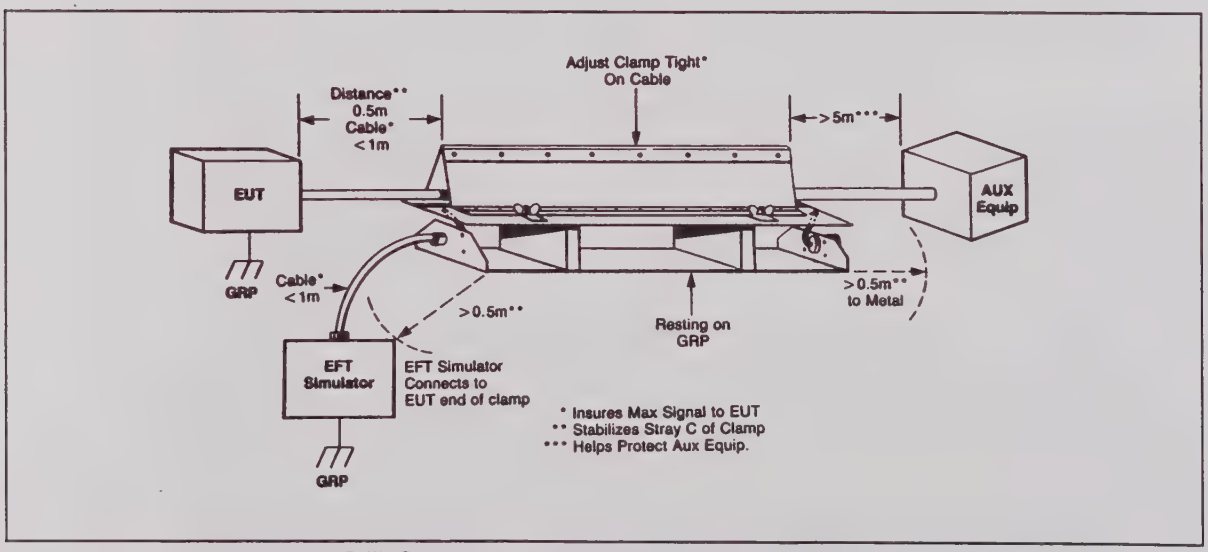

Figure 3-2. EFT Capacitive Coupling Clamp and Minimum Required Equipment Spacings

4. Other metals may be used, but must be at least 0.25 inches thick.

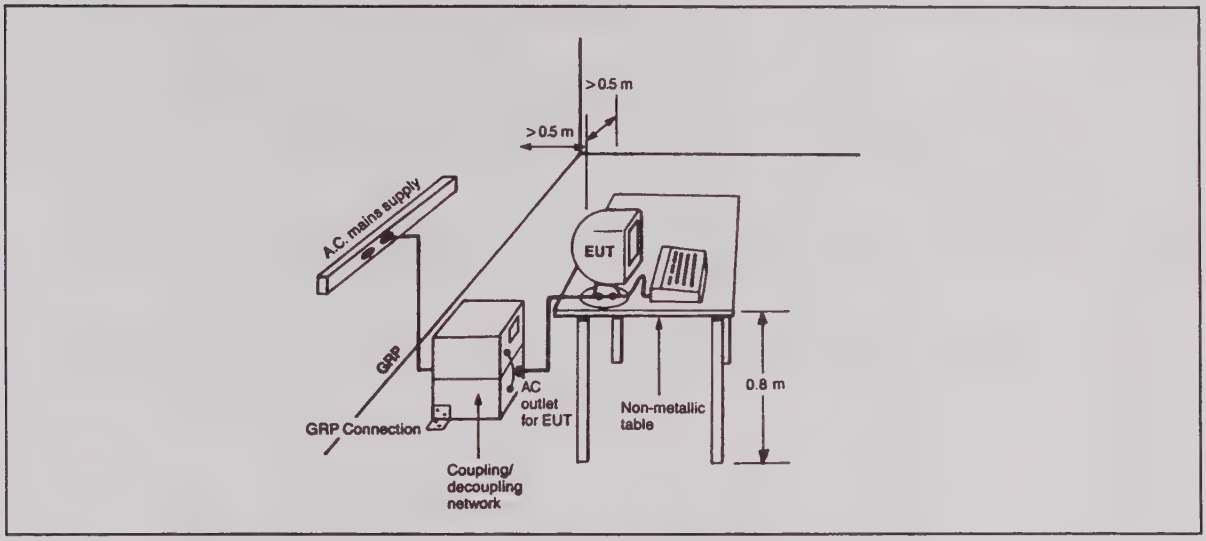

Figure 3-3a. Equipment Configuration - Benchtop EUT

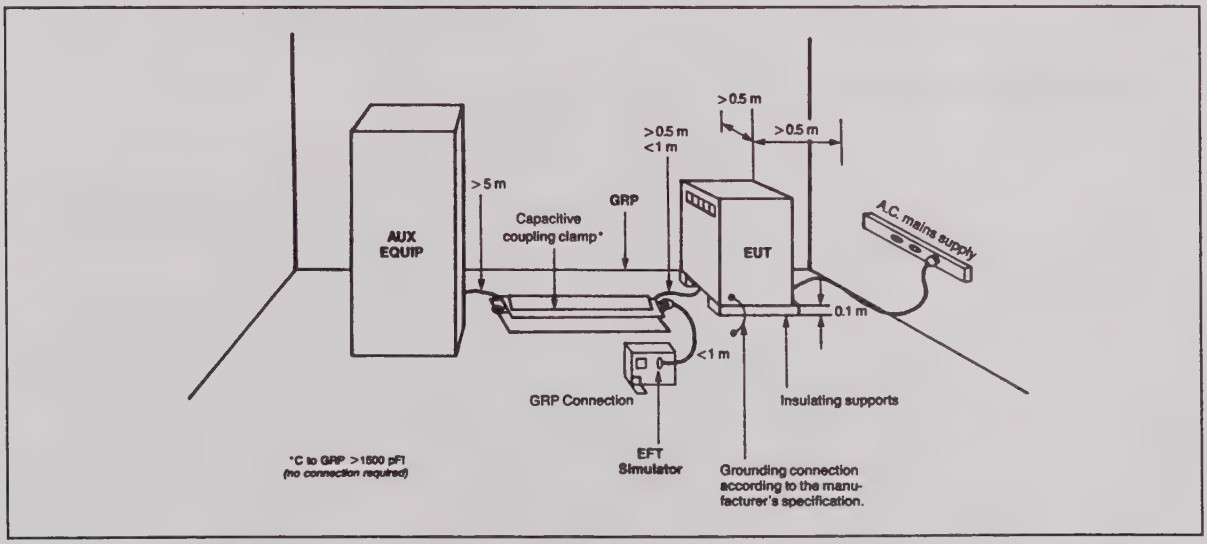

Figure 3-3b. Equipment Configuration - Floor-standing EUT

The following documents contain important information about the proper use of the ground plane and the cable coupling clamp in EFT/Burst testing.

- IEC publication 801-4, Electromagnetic Compatibility for Industrial-Process Measurement and Control Equipment; Part 4: Electrical fast transient/burst requirements.
- Electrical Fast Transient (EFT) Testing - An Overview, by Bruce Cormier and Warren Boxleitner. Proceedings of the IEEE EMC Symposium, Cherry Hill, NJ, Aug 13-15, 1991. Available as Application Note 251 from KeyTek.

Incoming Inspection and Unpacking

Upon arrival, inspect the shipping container for damage. If there is obvious external damage to the packaging, request that the carrier's agent be present during unpacking.

Depending on the equipment ordered, the instrument is shipped in a benchtop or floor-standing (roll-around) cabinet. The packaging for both systems is similar, but there are slight differences in the unpacking procedure.

If the shipping container is taller than 36 inches, the system is in a roll-around cabinet. Otherwise, the system is in a benchtop cabinet. Follow the appropriate procedure for your system.

Note

Do not destroy the shipping container during unpacking. Retain it for future shipment of the unit. The use of other containers may result in shipping damage.

Unpacking the Benchtop System

Referring to Figure 3-4, unpack the instrument as follows:

1. Position the shipping pallet near the final system location. Place it on the floor, a solid table, or a sturdy cart equipped with locking wheels. If unpacking the unit from a cart, lock the wheels before proceeding.
2. Cut and discard the shipping straps. Remove and retain the strap bumpers.
3. Lift the outer cardboard container up and away from the equipment. Slit all sealing tape at the top of the carton so the container can fold flat for storage.
4. There may be fragile items inside the accessory box. Handling it carefully, remove the accessory box and set it aside.
5. Remove and retain the shipping cap and the front cushion. Remove and retain the plastic bag from the instrument.
6. If the instrument is in a two-bay cabinet (i.e., if there are two layers of instruments mounted in the area below the front panel), remove the middle cable raceway cover by pressing inward on the detent pins at each side of the enclosure. This exposes a lifting point more convenient to use than the bottom of the unit.

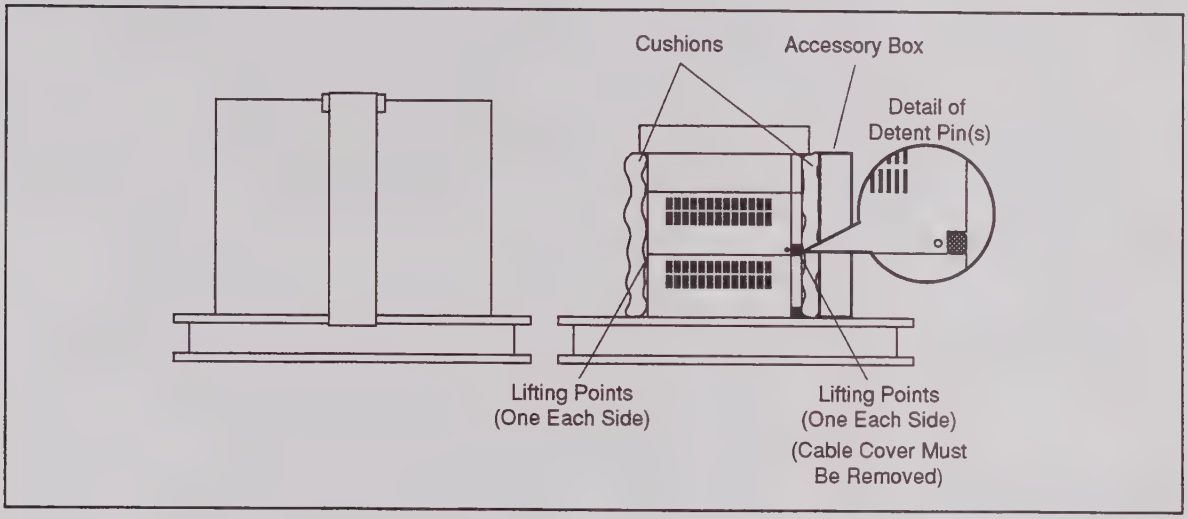

Figure 3-4. Shipping Package, Benchtop System

Warning
Depending on the configuration, the complete instrument may weigh more than 100 pounds. Use proper lifting techniques.

7. If the system is too heavy for lifting, remove one or more instrument modules. Follow the procedure given in *Removing and Installing Instrument Modules* at the end of this chapter.

Warning
Do not attempt to lift the ECAT system or any module using the clear plastic door located on the front of the module.

Caution
Many half-width modules can be safely lifted by one person; most full-width modules require at least two persons.

8. Lift the instrument clear of the pallet and place it on the bench.
9. If instrument modules were removed, install them according to the procedure *Removing and Installing Instrument Modules* given later in this chapter.
10. Attach the cable raceway cover previously removed.
11. Open the accessory box and remove the contents. Slit all sealing tapes and fold the box flat for storage. Locate the cable raceway cover packed in the accessory box and install it at the base of the unit. Do not attempt to install any other items from the accessory box at this time.
12. Collect all the packing materials, tie or tape them into a bundle for storage, and save the materials for shipping. KeyTek recommends the equipment periodically be returned to the factory or to a certified service facility for maintenance and calibration. To prevent possible damage during shipment, use the original packing material or obtain new material from KeyTek.
13. Verify all parts against the packing list.
14. Examine each assembly for physical damage. If there is damage, notify the carrier and follow their instructions for damage claims. Report shipping problems immediately to KeyTek.

Unpacking a Floor-standing (Roll-around) System

Referring to Figure 3-5, unpack the instrument as follows:

1. Position the shipping pallet on the floor near the final system location.
2. Cut and discard the shipping straps. Remove and retain the strap bumpers.
3. Lift the outer cardboard container up and away from the equipment. Slit all sealing tapes at the top of the carton so the container can fold flat for storage.
4. Remove the wooden ramp and set it aside.
5. There may be fragile items inside the accessory box. Handling it carefully, remove the accessory box and set it aside.
6. Remove and retain the shipping cap and the front cushion. Remove and retain the plastic bag from the instrument.
7. Release the unit from the shipping pallet.
8. Remove the cable raceway cover under the second row of instrument modules by pressing inward on the detent pins at each side of the enclosure and removing the cover. This exposes a convenient grasping point for rolling the unit off the pallet.

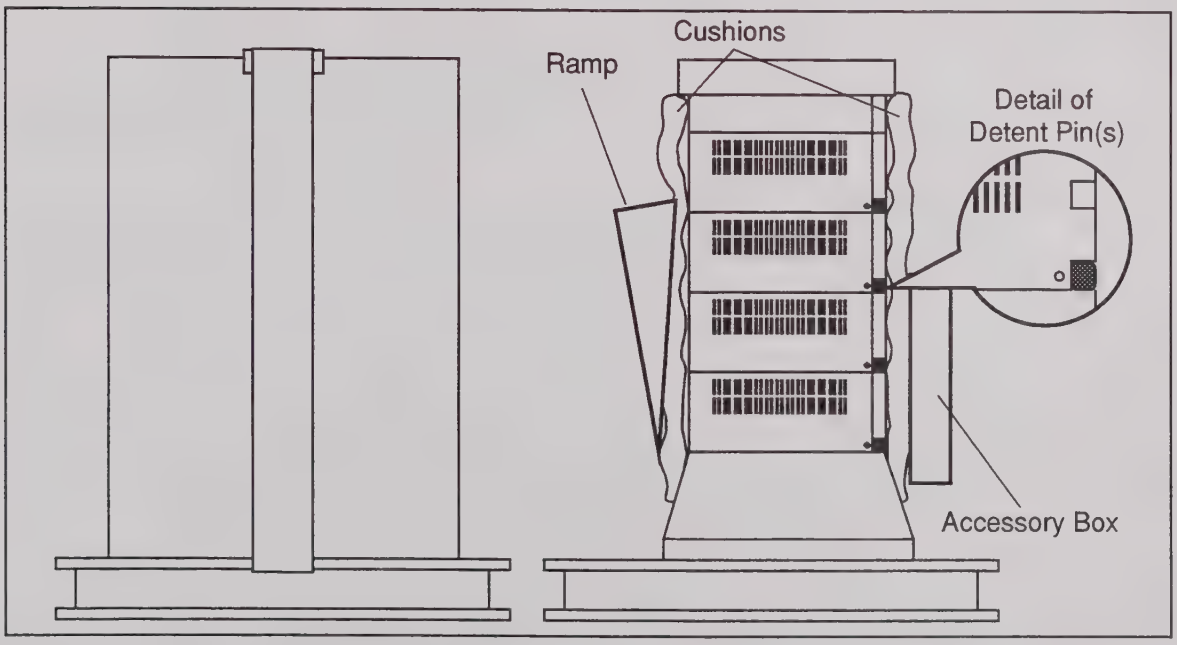

Figure 3-5. Shipping Package, Floor-standing (Roll-around) System

9. Place the wooden ramp at the front of the unit and roll the system off the pallet onto the floor. Set the ramp and pallet aside.
10. Attach the cable raceway cover that you previously removed.
11. Open the accessory box and remove the contents. Slit all sealing tapes and allow the accessory box to fold flat for storage.
12. Locate the cable raceway cover packed in the accessory box and install it at the base of the unit. Do not attempt to install any other items from the accessory box at this time.
13. Collect all the packing materials, tie or tape them into a bundle for storage, and save the materials for shipping. KeyTek recommends the equipment periodically be returned to the factory or to a certified service facility for maintenance and calibration. To prevent possible damage during shipment, use the original packing material or obtain new material from KeyTek.
14. Verify all parts against the packing list.
15. Examine each assembly for physical damage. If there is damage, notify the carrier and follow their instructions for damage claims. Report shipping problems immediately to KeyTek.

Physical Installation

Allow at least six inches clearance from the wall or other equipment on both sides of the instrument for proper air flow. The system must be mounted vertically on a level surface.

Place the benchtop instrument on a table that can support the weight of the unit. It may also be placed on a sturdy cart. However, since the unit is heavy, make certain that the instrument and cart combination is stable, and cannot be easily tipped - particularly if the wheels strike a bump on the floor such as the edge of a rug, a pebble or a small piece of hardware.

Stabilize a roll-around system by seating the leveling legs located at the base of the unit. Lower the legs far enough to remove most of the weight from the casters.

Before moving the roll-around system, completely raise the leveling legs and take care that the system does not get caught on bumps on the floor or carpet. Do not operate the system without the leveling legs in place.

Electrical Installation

Electrical installation is straightforward since all wiring, both the AC supplies and the testing and measurement lines, attach to the instrument using industry standard connectors.

Review the site considerations at the beginning of this chapter and all safety precautions located at the front of this manual before attempting to connect the system.

After all AC lines are installed, have a qualified electrician verify the wiring. In particular, be sure the Protective Earth (PE) grounds are properly connected. Also verify the integrity of the ground connection at both ends of the power cables for all test equipment used.

Instrument AC Connections

Use dedicated AC lines to supply instrument and other equipment that will be used during surge testing. Preferably, run the lines directly from the service entrance of the facility to outlets in the test area near the equipment. The rating of the AC supply to the instrument must be 100 V to 240 V 50/60 Hz, approximately 300 watts maximum.

Make sure the instrument power cord reaches the AC supply outlet, but do not plug in the ECAT system at this time.

EUT Mains Connections

The AC supply for the EUT must be a dedicated line. This is because an EUT failure during a test may trip the circuit breaker in the AC supply to the EUT.

Run the AC line directly from the building service entrance (or from an MG set or isolation transformer) to a suitable circuit breaker and a compatible outlet in the test area near the instrument; having the breaker located nearby saves time during testing.

The EUT power cables[5] must have a current carrying capacity matching the circuit breaker rating of the AC supply line. This is especially true if the circuit breaker rating is much higher than the normal operating current rating of the EUT. Should there be a component failure in the EUT during testing, the EUT power lines could be subjected to overcurrent until the breaker trips.

If EUT power is supplied through both a coupler/decoupler and a PQF source connected in series, wire the coupler/decoupler upstream in the line (closer to the AC wall outlet). KeyTek supplies a cable to connect the output of the PQF source to the input of the coupler/decoupler.

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[5] Consider all cables in the EUT mains supply: (1) between the AC mains supply outlet and either at the coupler/decoupler or the PQF source, (2) between the coupler/decoupler or PQF Source and the EUT, and (3) between the coupler/decoupler and the PQF source if both are connected in series.

Coupler/Decoupler Mains Connections

Using the power cable provided with the instrument, connect the coupler/decoupler AC input connector (labeled Test AC Input) to the AC supply outlet. For single phase coupler/decouplers of 20 A rating or less, the input connector at the instrument is an IEC 320. For all other units, the connector is a Hubbell twist-lock connector.

Confirm that the power cable on the EUT matches the AC output connector (labeled Output to EUT) on the coupler/decoupler. Do not plug in the EUT at this time.

Test Connections

A variety of standard test setups do not need separate test wiring. These include:

- PQF testing through the EUT power cable
- Surge testing through a coupler/decoupler via the EUT power cable
- EFT/Burst testing via the EUT power cable when using an EFT/Burst source with an integral coupler/decoupler

Other setups use special test leads. These include:

- Surge test using a data, signal or telecom coupler/decoupler
- EFT/Burst testing through a separate coupler/decoupler, even when the test is applied to the EUT power cable
- EFT/Burst testing using a cable coupling clamp
- Any surge or EFT/Burst test applied directly to the EUT, bypassing the AC power line

---

Note
Do not install any test wiring at this time.

When external wiring is needed for surge or PQF testing, connect it to the instrument using gold-plated banana plugs[6] rated for 32 amps. This is both for safety and to ensure that the banana jacks on the instrument will not deteriorate over time. Be sure the wiring is fully insulated with a rating not less than twice the applied peak open circuit voltage. Solder the conductor to the banana plugs and do not leave exposed conductor at the connectors.

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6. On a three phase coupler/decoupler fitted with the Hubbell connector for EUT output power, clearance is very tight between some of the banana jacks and the Hubbell plug. Low profile banana plugs must be used to make connections to the middle rows of banana jacks.
Multi-Contact makes a line of high voltage banana plug test leads and accessories.
In the US: Multi-Contact USA, 5560 Skylane Boulevard, Santa Rosa, CA 95403-8224, Tel (707) 575-7575.
In Europe: Multi-Contact AG Basel, Stockbrunnenrain 8 + 12, CH-4123 Allschwil 1, Switzerland,
Tel (061) 302 3434

When powering an EUT from the coupler/decoupler via the banana connectors, make certain that the current carrying capacity of all wiring and connectors meets the rating of the circuit breaker in the AC supply to the EUT. This is particularly important if the circuit breaker rating is higher than the current rating of the EUT. If there is a component failure in the EUT during testing, the EUT mains wiring could be subjected to overcurrent until the breaker trips.

When using the KeyTek capacitive coupling clamp or a separate mains coupler/decoupler, a special interlocked cable provided by KeyTek is needed. KeyTek supplies two versions of this cable; each is intended for a specific use and fits only one of the two output connector blocks of an EFT/Burst source.

The cables can be identified by length. The short cable (about 14 inches long) is designed to run from the OUT2 connector block on the EFT/Burst source to the EFT/Burst IN on the coupler decoupler. The long cable (about 3 feet long) connects between the OUT1 connector block on the EFT/Burst source to the KeyTek cable clamp.

For applications not requiring the interlocked cable, an appropriate RF-carrying cable with an HN style RF connector can be used for connecting to the EFT/Burst source.

The ECAT system provides voltage and current outputs to an external oscilloscope or other high frequency transient-recording device for monitoring surge current and voltage waveforms. This eliminates the need for specialized cabling and differential measurement probes for most test configurations.

Caution
Do not defeat the PE connection on the oscilloscope. This is not necessary in order to achieve suitable measurement performance, and doing so introduces an unnecessary hazard to personnel and equipment.

These monitor outputs can be used without special consideration beyond ensuring the oscilloscope ground (PE) connection is not defeated. Use well shielded coax cable, 95% coverage or better, with BNC connectors tying the V Mon and I Mon outputs to the monitor. The initial checkout procedure described in the next chapter can be used as a guideline for setting up an oscilloscope.

However, in certain surge test configurations, such as measuring the let-through voltage of a crowbar protector, it may be necessary to revert to direct measurement techniques. Direct measurement techniques require more care, both from the standpoint of achieving accurate measurements and for maintaining safe conditions for personnel and equipment. Guidelines and two examples illustrating direct measurement techniques are given later in this chapter.

Surge Voltage Monitor Input Jumpers

The voltage monitor requires that jumpers be installed to tailor the system to the specific needs of the planned test method. The setup described here is appropriate for initial checkout and correct for most testing. No jumpers are required for the current monitor.

The configuration of voltage jumpers depends on the options installed in the surge networks and the power line coupler/decoupler.[7] Some of the following options may not be present on your system.

All coupler/decouplers require two jumpers. More are needed if the extended V-I monitor option is installed. Surge networks have voltage monitor inputs only if the V-I monitor option is installed.

Power Line Coupler/Decouplers - Surge and EFT/Surge power line coupler/decouplers are equipped with the standard voltage monitor and may also be fitted with the extended monitor option.

Standard units have two banana connectors on the front of the module and one or more blank connector positions. Units with the extended capability have three or more banana connectors, and no blank connector positions. The banana connectors are labeled V Mon In A, V Mon In B, V Mon In C, and so on.

Using the short banana plug jumpers supplied with the unit, connect each voltage monitor input to the coupler/decoupler output terminal located immediately next to it. For example, connect:

- V Mon In A to L1 (all units)
- V Mon In B to L2 (all units)
- V Mon In C to PE (single phase units, extended function)

or

- V Mon In C to L3 (three phase units, extended function)
- etc.

[7] The I/O line coupler/decoupler does not have jumper-connected voltage monitor inputs.

Surge Networks - Standard surge networks have no voltage monitor input connectors and all connector positions labeled V Mon In are blank. Surge networks with the V-I monitor options installed have two or more banana connectors, labeled V Mon In A, V Mon In B, V Mon In C, etc.

There are no blank connector positions on surge networks with the V-I monitor installed except for the E502 and E506 surge networks. They have one blank connector position that is unused and reserved for future use.

Using the short banana plug jumpers supplied with the unit, connect each voltage monitor input to the surge network output terminal located immediately next to it. For example, connect:

- V Mon In A to HI
- V Mon In B to LO (labeled differently on certain networks)
- V Mon In C etc. (present only on certain networks)

Two Specialized Surge Measurement Configurations

Differential EUT Measurement - Using ECAT - Occasionally, voltage measurement inputs must be taken directly from the EUT, not from the surge network or coupler/decoupler output terminals. The measurement must be made differentially. The two voltage measurement wires to the EUT must:

- have a dielectric rating twice that of the highest surge voltage planned.
- be of the same length.
- be run together in a relatively straight path with no loops; use cable ties to keep the two wires together, or lightly twist them together.
- be connected to any two voltage monitor inputs located on the same instrument module.

Differential EUT Measurement - Bypassing ECAT - In some instances, a test configuration dictates the direct connection of the scope to the EUT, bypassing (or in parallel to) the ECAT measurement facilities. This setup should be attempted only by experienced test engineers. Use balanced, differential, high voltage probes, such as KeyTek Model PK1001D and PK1002D, connected according to the guidelines of ANSI/IEEE C62.45-1987.

Figure 3-6 shows the proper configuration for making such measurements. It is absolutely critical that:

- the high voltage probes have no ground lead attached to the EUT.
- the chassis of the oscilloscope or other device is safely grounded by the PE conductor of its power cord.

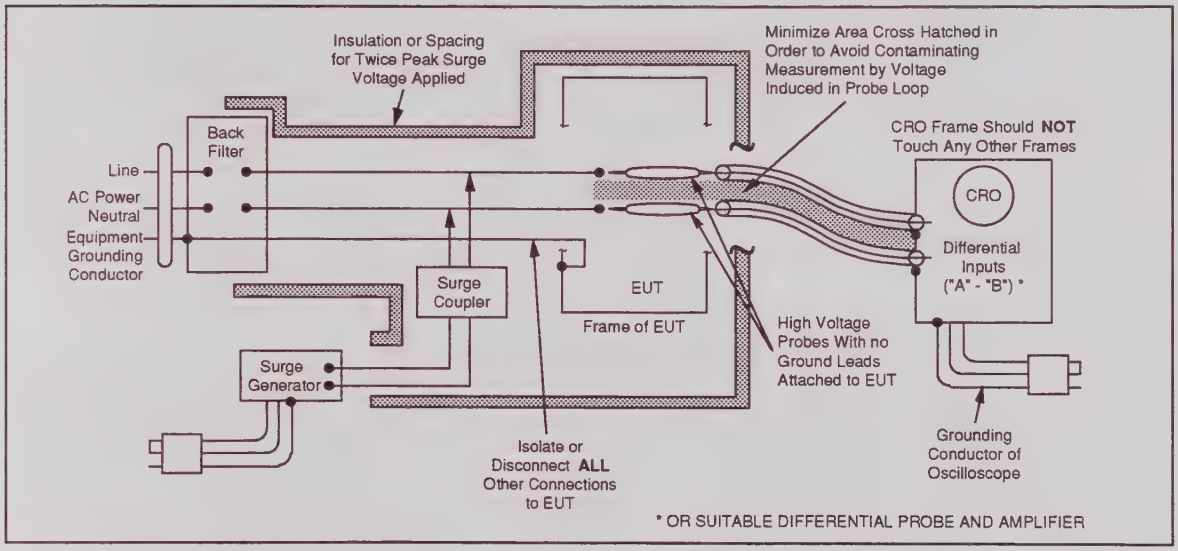
Insulation or Spacing for Twice Peak Surge Voltage Applied
Minimize Area Cross Hatched in Order to Avoid Contaminating Measurement by Voltage Induced in Probe Loop
CRO Frame Should NOT Touch Any Other Frames
Back Filter
Line
AC Power Neutral
Equipment Grounding Conductor
CRO
Differential Inputs ("A" - "B") *
Surge Coupler
EUT
Frame of EUT
High Voltage Probes With no Ground Leads Attached to EUT
Surge Generator
Isolate or Disconnect ALL Other Connections to EUT
Grounding Conductor of Oscilloscope
* OR SUITABLE DIFFERENTIAL PROBE AND AMPLIFIER

Figure 3-6. Direct Measurement Setup

FiberCom Connections

FiberCom is an option used to control the ECAT system from an external computer running the ECAT application software under Microsoft Windows 3.x[8].

If this option is included with your system, you will find a small module, the FC-11, packed in the accessory box. The module has two cables running from it: a short RS-232 cable fitted with a D-shell (DB-9) connector at the end, and a fiberoptic cable with a duplex modular connector. The fiberoptic cable attaches to the ECAT system and the RS-232 cable connects to the computer. No power cable or supply is included with the FC-11; it derives power from the RS-232 port of the computer.

[8] Windows 3.x refers to Microsoft Windows™, Version 3.1 and later.

Fiberoptic Connection

Connect the modular connector on the fiberoptic cable into the mating connector on the rear of the ECAT system. The connector is polarized; the small tab on the connector should face upward. Do not force the connector on in the wrong orientation.

RS-232 Connection

The RS-232 connector must be plugged into a computer serial port, COM1 or COM2. COM1 is the default location assumed by the software. If FiberCom is plugged into COM2, follow the procedure *Changing the COM Port*, below, after installing the software.

It is important to make sure the system mouse or any other serial device does not conflict with FiberCom[9]. For most installations, this problem is avoided by plugging FiberCom into COM1 and the mouse into COM2, or vice versa.

FiberLoop Connections

The FiberLoop option extends the system interlocks to include entries and exits to the test areas, as well as smoke alarms, panic buttons and other monitors. It is also used for remote monitoring at the EUT and a variety of other functions. The FiberLoop system plugs into a pair of fiberoptic connectors, labeled T_x and R_x, located on the right side of the ECAT control panel.

Installation and operation are described in a separate manual supplied with the option. To simplify familiarization of the ECAT instrument, defer the installation of FiberLoop until later. However, if the option is present, the interlock must be closed with a shorting jumper in order for the Familiarization procedures in Chapter 4 to work.

If the FiberLoop option is installed in your ECAT system, you will find a fiberoptic shorting jumper packed in the accessory box. In most cases one or more FiberSense modules are also packed in the box. If the option is not installed, a shorting jumper is not required; ignore the following two paragraphs.

Plug the shorting jumper into the connectors T_x and R_x. Insert one end of the jumper into each connector, and gently push it in until the detent engages. This is required to complete the interlock.

If the jumper is not properly installed when the ECAT system is turned on, the system reports an error via either SurgeWare or the Virtual Front Panel. If the interlock is opened while the system is running, the SurgeWare or the Virtual Front Panel immediately displays an error message.

9. This can happen if the mouse port and the FiberCom port share the same IRQ line in the computer. On most PC systems, COM1 and COM3 share the same IRQ and COM2 and COM4 share the same IRQ. Assigning FiberCom and the mouse to COM1 and COM2 usually avoids a problem.

Firmware and Software Installation

Firmware

The firmware running the ECAT system cabinet and Virtual Control Panel is factory installed. If KeyTek supplies an updated version of the firmware, it can be installed in the field according to the procedure given in Chapter 6.

Microsoft Windows™ Software

The software that runs under Microsoft Windows on an external computer is supplied on diskette and must be installed before use. The installation program, Setup, is run from Microsoft Windows, Version 3.1 or later.

1. Insert the ECAT release disk into the diskette drive.
2. From Program Manager, File Manager, or an equivalent Windows shell, pull down the *File* menu and select *RUN....* Windows displays a dialog box requesting the name and path of the program.
3. Enter the diskette drive path, followed by the name of the installation program, for example:

   A:\SETUPKT.EXE
4. Click OK.
5. Follow the instructions on the screen to complete the installation.

   Setup copies the ECAT control programs, libraries, data files, and some demo programs onto the hard disk, creating a program group called KeyTek Control. The program group contains icons for SurgeWare, BurstWare and PQFWare.
6. Using File Manager, check if a file Readme.txt is on the distribution diskette. If the file exists, print it out or read it (e.g., use the Windows Notepad) to obtain updated information about the software.

Changing the COM Port

By default, the ECAT software expects to find FiberCom connected to COM1. If COM2 is used instead, step through the following procedure for each program item in the Keytek Control program group.[10]

From Program Manager or another Windows shell:

1. Open the *KeyTek* program group.
2. Single click on the *ECAT* program icon.
3. Pull down the Program Manager *File* menu and select *Properties....*
4. In the edit box labeled *Command Line*, add

   <space>COM2

   immediately following the program name. Be sure to type *COM2* exactly as shown (in upper case letters) with a space in front of it.
5. Click *OK*.
6. Repeat for each program item (e.g., SurgeWare, PQFWare, Burstware.)

[10] SETUPKT also includes an option to automatically set this parameter during installation. Choose the *COM2* option from the *install* menu, and the program will automatically configure the software as needed.

Initial Power Up

1. Make sure the instrument is unplugged and that there is no wiring connected to the front panel.
2. If FiberCom is present (see FiberCom Connections earlier in this chapter), it should be connected between the rear of the instrument and the external computer as previously described. The computer should be turned off.
3. If FiberLoop is present (see FiberLoop Connections earlier in this chapter), check that the fiberoptic shorting jumper is installed between the two FiberLoop connectors on the control center.
4. Turn the System Power switch *off*. Refer to Figure 3-7.
5. Pull out the red Stop switch on the right side of the control center.
6. Press the *EUT Mains* switch once or twice as needed to turn it *off* (i.e., latched outward).
7. Plug in the simulator AC mains power cord.
8. Turn System Power *on*. If the Virtual Front Panel is present, it displays a self test screen.
9. Press the red Stop button. The system turns *off* and all indicator lights go out.
10. Pull the red Stop button out. The system turns *on* again.
11. Press *EUT Mains*. It should not illuminate because EUT power has not yet been enabled from the menus. Press it again so that it latches outward.

This completes the initial power up. Refer to Chapter 4, *Familiarization*, for information on performing a quick checkout of the system.

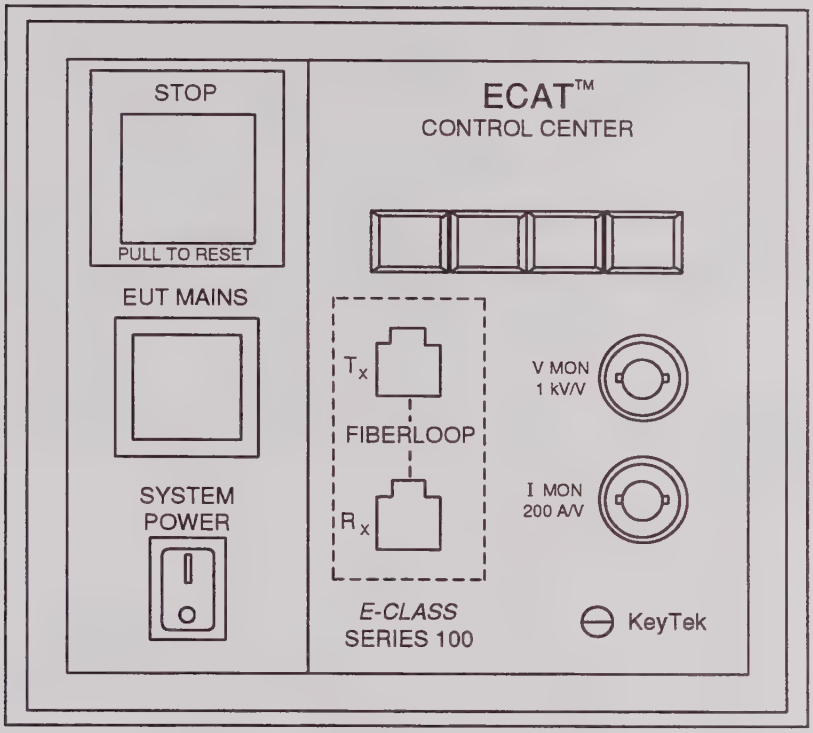

Figure 3-7. Control Center

Removing and Installing Instrument Modules

During installation it may be necessary to remove an instrument module in order to lighten the ECAT system.

Warning
Some individual modules, particularly the full-width units, may weigh too much for safe lifting. KeyTek warns against trying to lift such modules by hand and recommends removing heavy modules by sliding them onto the tray of an elevator cart rated for loads of at least 200 pounds.

To Remove a Module

1. If the system is not turned off, turn it off.
2. If the system power cord is plugged in, unplug it.
3. If EUT power cords are plugged into a coupler/decoupler, unplug them.
4. Take the cable raceway cover off of the module to be removed.
5. Remove the locking screw(s). A half-width module has one screw located at the bottom center of the unit; a full-width module has two screws, one in the bottom center of each side of the unit.
6. Grasp the module on both sides and give it a firm tug to unseat the connectors at the rear of the module. Do not allow the module to slide out of the cabinet more than an inch or two.

Caution
Do not pull on the clear plastic door at the front of the module.

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7. Continue to slide the module out about 1 foot and test its weight to be sure you can lift it. When it has slid out over 15 inches, change your grip so as to carry the entire weight of the unit. Do not try to carry the module by the front grips.

Warning
Do not lift an instrument module using the clear plastic door.

8. Slide the unit free of the cabinet and set it on a bench.

The ECAT system will not operate if any slots are open. Cover any vacant slot(s) of the cabinet with a blank panel (Model E000, available from KeyTek) before attempting to run the system with a module removed.

To Install a Module

To install the unit, reverse the previous procedure. Be sure the hold-in screws for each instrument module are installed and tightened before attempting to use the system.

Chapter 4
Familiarization

The familiarization procedure described here takes less than one hour to complete, and provides a broad overview of how to use the system. However, for a full understanding of how the system operates, consult Chapter 5. These procedures should only be performed by personnel familiar with pulsed-EMI testing. The procedures cover:

- Powering up the system
- Becoming familiar with both the ECAT Virtual Front Panel and Microsoft Windows-based test software
- Performing a simple surge, EFT/Burst, and PQF test and displaying the resultant waveforms of each on a digital oscilloscope

When the procedures are followed as described, there is no high voltage hazard present external to the KeyTek instrument cabinet. It is safe to operate the equipment with the FiberLoop option disabled using the fiberoptic shorting jumper provided. Depending on your installation, this could disable certain test area entry/exit interlocks. At all other times, FiberLoop should be connected and activated.

Caution

If the instrument fails to perform as expected during initial familiarization, you should halt testing and immediately turn the equipment off. Check with the KeyTek factory or your authorized support representative before proceeding.

Getting Familiar With the ECAT System

Powering Up

1. Make sure the instrument is unplugged and that there is no wiring connected to the front panel.
2. If FiberCom is present, it should be connected between the rear of the instrument and the external computer as previously described. The computer should be turned off.
3. If FiberLoop is present, check that the fiberoptic shorting jumper is installed between the two FiberLoop connectors on the control center.
4. Turn the *System Power* switch off. Refer to Figure 4-1.
5. Pull out the red *Stop* switch on the right side of the Control Center.
6. Press the *EUT Mains* switch once or twice as needed to turn it off (i.e., latched outward).
7. Plug in the ECAT system power cord.
8. Turn *System Power* on. If the Virtual Front Panel is present, it displays a self test screen.
9. Press the red *Stop* button. The system turns off and all indicator lights go out.
10. Reset *Stop*. The system turns on again.
11. Press *EUT Mains*. It should not illuminate because EUT power has not yet been enabled from the menus. Press it again so that it latches outward.

This completes the power up procedure.

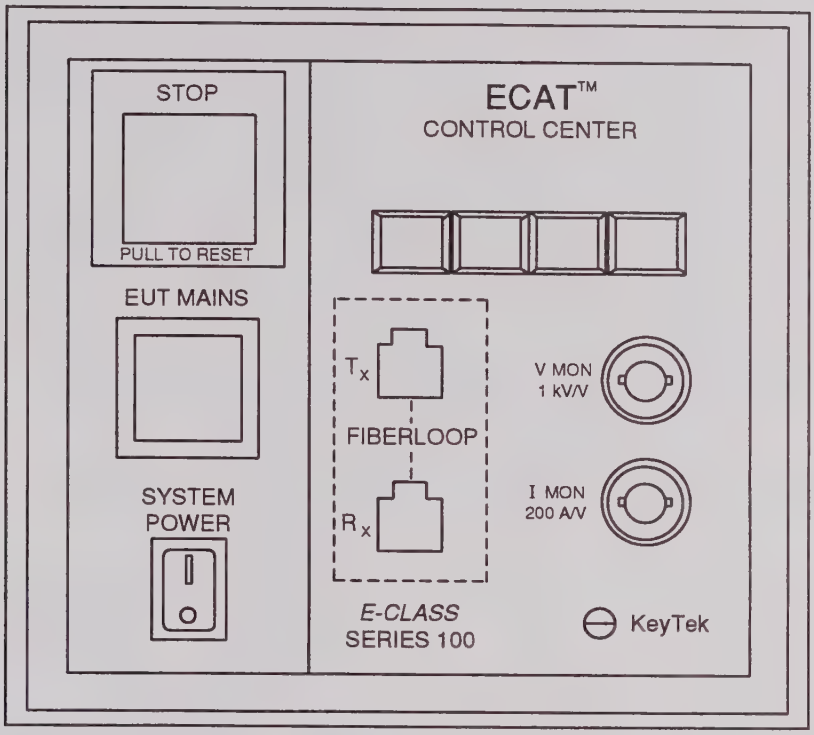

Figure 4-1. Control Center

Familiarization with the Virtual Front Panel (VFP)

Immediately after power up, if the Virtual Front Panel (VFP) is present, it displays a self test screen. At the completion of the automatic process, the VFP displays the system Main Menu as shown in Figure 4-2.

If an external computer running Microsoft Windows-based ECAT software is present, the screen may display the message *Remote*. If so, press the *Menu* key (located beneath the bottom-right corner of the display) to remove the message and return control of the instrument to the VFP.

VFP Display Contrast Adjustment

1. Set the contrast to a comfortable level.
   a. Press ↓ several times. The display darkens.
   b. Press ↑ several times. The display lightens.
2. Proceed to review the VFP menus for each instrument group present in the system.

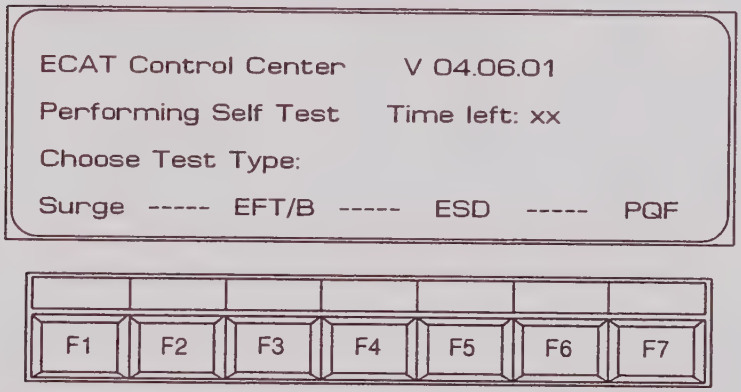

Figure 4-2. System Main Menu After Self Test

VFP Familiarization, Surge

Press the *Menu* key and then press the F1 function key. If a surge module is installed in the system, the Surge Test menu, similar to that shown in Figure 4-3, appears.

If a surge module is not present, the VFP reports an error; skip the remaining steps in this section and proceed to *VFP Familiarization, PQF*.

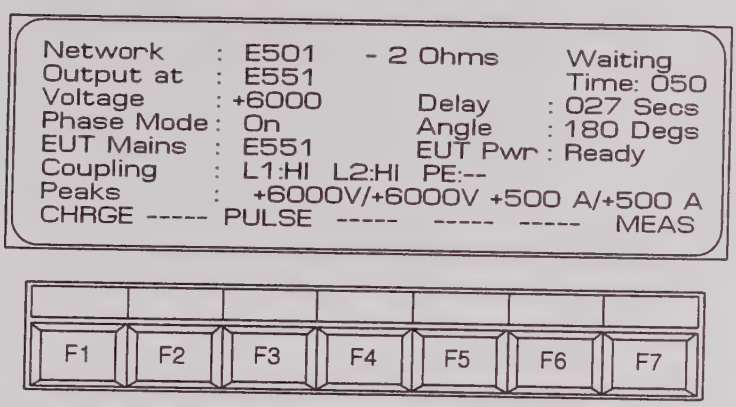
Network : E501 - 2 Ohms Waiting
Output at : E551 Time: 050
Voltage : +6000 Delay : 027 Secs
Phase Mode : On Angle : 180 Degs
EUT Mains : E551 EUT Pwr : Ready
Coupling : L1:HI L2:HI PE:--
Peaks : +6000V/+6000V +500 A/+500 A
CHRGE ----- PULSE ----- ----- ----- MEAS
F1
F2
F3
F4
F5
F6
F7

Figure 4-3. Surge Test Menu

1. Press the F7 on the VFP. The Measurement menu, similar to that shown in Figure 4-4, appears.

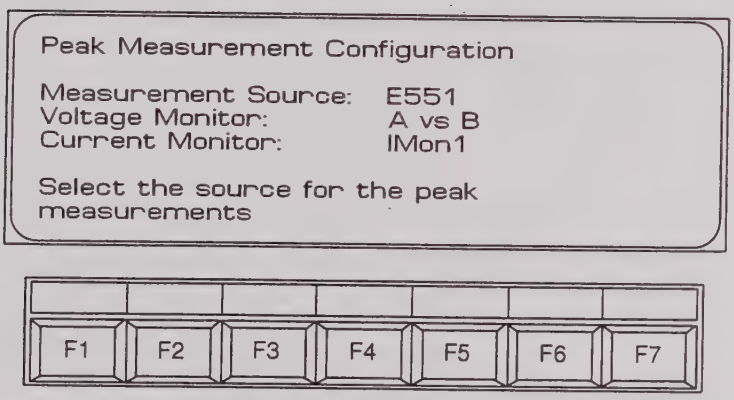

Figure 4-4. Measurement Menu

2. Press *Menu* to return to the Surge Test menu.
3. Press ↓ several times. The reverse-video cursor steps vertically through the fields on the menu.
4. Press ↑ several times. The reverse-video cursor steps backward through the same fields.
5. Select the field labeled *Network*.
6. Press ← or → to move horizontally from field to field on the same line.
7. Select the field labeled *Voltage*.

8. Press *CE* on the numeric keypad. The field clears. Then press the keys *5 6 7 9* followed by *Enter* to fill in a new value.
9. Select the left-most field of the line marked *Network*.
10. Press *Enter*. If there is more than one surge network present, the value in this field changes. Repeatedly press *Enter* to step through the available options.
11. Confirm that the model number of each installed surge network appears in the list. The model number of each surge network appears in the top left corner of the unit. If there is only one surge network present, the field does not change.

Note
If a coupler/decoupler is not present, skip the following two steps.

---

12. Select the field *Output at*. The field displays the model number of the surge network presently selected in the field *Network*.
13. Press *Enter* to select a coupler/decoupler output. If there is more than one coupler/decoupler present, repeatedly press *Enter* to step through the available options. Confirm that the model number of each installed coupler/decoupler appears in the list. The model number of each coupler/decoupler appears in the top left corner of the unit.

Note
If a coupler/decoupler is not present, and none of the surge networks have the V&I Option installed, this completes the familiarization for the VFP. Otherwise, continue as follows.

---

14. Press F7. The Measurement menu appears.
15. Press ↓ or ↑ several times. The reverse-video cursor steps vertically through three fields on the menu.

VFP Familiarization, PQF

1. Repeatedly press the *Menu* key until the main menu, previously shown in Figure 4-2, appears.
2. Press the F7 function key. If a PQF module is installed in the system, the PQF menu, similar to that shown in Figure 4-5, appears.
3. If a PQF module is not present, the VFP reports an error. Skip the remaining steps in this section and proceed to *VFP Familiarization, EFT.*
4. Press the F1 function key, labeled *INS* on the display, three times. Three new lines, each designating a PQF output level, appear between the lines marked *Start* and *End.*
5. Press ↓ several times. The reverse-video cursor steps vertically through the test steps in the list, between *Start* and *End.*
6. Press ↑ several times. The reverse-video cursor steps backward through the same lines.

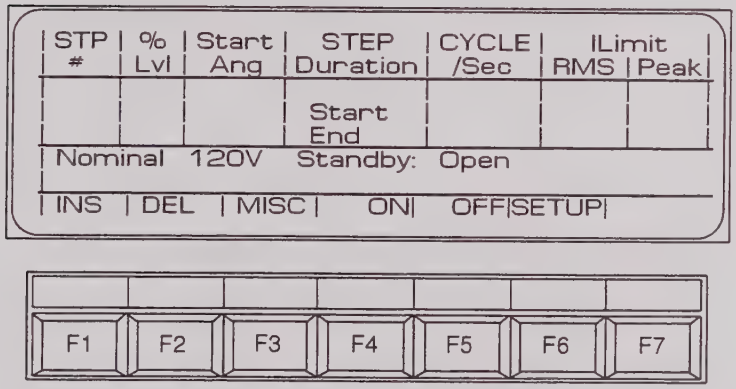

Figure 4-5. PQF Menu

7. Press → to move horizontally through the fields on the line.
8. Press ← to move the digit cursor (the underline character) through the individual digit positions of a field. When the digit cursor moves past either end of one field, it skips to the adjacent field, if there is one, on the same line.
9. Press → repeatedly until the cursor is under the column labeled *% LVL.*

10. Repeatedly press the *Enter* key. The display steps through each of the allowable values for the field
11. Position the cursor under the column labeled *Start Angle.*
12. Press *CE* on the numeric keypad. The field clears. Then press the keys *1 8 0* followed by *Enter* to lock in the new value.
13. Locate the function key F2, labeled *DEL* on the display. Press F2 three times to remove the newly entered PQF output levels.

VFP Familiarization, EFT

1. Repeatedly press the *Menu* key until the main menu, previously shown in Figure 4-2, appears.
2. Press the F3 function key. If an EFT module is installed in the system, the EFT menu, similar to that shown in Figure 4-6, appears.
3. If an EFT module is not present, the VFP reports an error. Skip the remaining steps below and proceed to the next section.
4. Press ↓ several times. The reverse-video cursor steps vertically through the fields on the menu.
5. Press ↑ several times. The reverse-video cursor steps backward through the same fields.

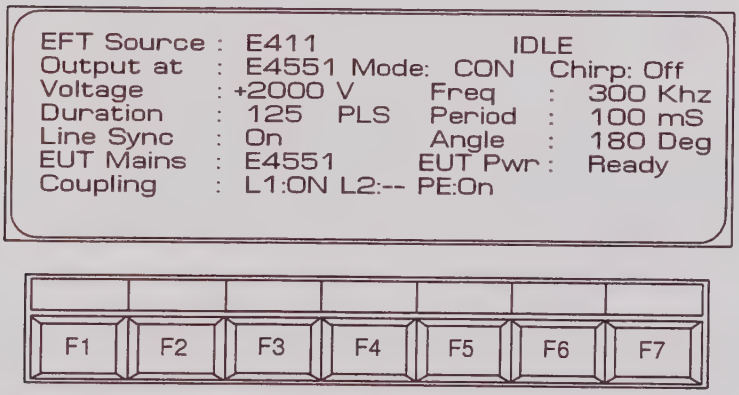
EFT Source : E411 IDLE
Output at : E4551 Mode: CON Chirp: Off
Voltage : +2000 V Freq : 300 Khz
Duration : 125 PLS Period : 100 mS
Line Sync : On Angle : 180 Deg
EUT Mains : E4551 EUT Pwr : Ready
Coupling : L1:ON L2:-- PE:On
F1
F2
F3
F4
F5
F6
F7

Figure 4-6. EFT Menu

6. Select the field labeled *Output at.*
7. Press ← or → to move horizontally from field to field on the same line.
8. Select the field labeled *Voltage.*

9. Press *CE* on the numeric keypad. The field clears. Then press the numeric keys *5 6 7 9* followed by *Enter* to fill in a new value.
10. Select the left-most field of the line marked *Output at*.
11. Press *Enter*. The value in this field changes; the new value depends on which EFT modules are installed.

    For an EFT source that does not have an integral coupler/decoupler, the value toggles from *OUT1* to *OUT2*. If there is a separate coupler/decoupler in the system, pressing *Enter* again displays the model number of the coupler/decoupler[1].

    For an EFT source with an integral coupler/decoupler, the display toggles between *OUT1* and the model number of the coupler/decoupler.

[1] To couple the EFT/Burst signal onto the AC mains using a separate coupler/decoupler (e.g. E4551), set *Output at* to the model number of the target coupler/decoupler, **not** *OUT2*.

Becoming Familiar with Windows-based Software

Microsoft Windows Software Familiarization, SurgeWare

To check out SurgeWare, start with the ECAT system turned off. Be sure that there are no external connections to the output connectors of any surge module or coupler/decoupler.

1. Turn on the ECAT System.
2. Turn on the computer where SurgeWare is installed.
3. Bring up Microsoft Windows in the customary fashion.

Start up SurgeWare as follows:

4. If the program group labeled *KeyTek Control* is not already open, open it by double clicking on the group icon.
5. Double click on the SurgeWare icon. SurgeWare displays the *About...* dialog box listing all the modules installed in the ECAT system.

Note

If SurgeWare is unable to connect to the ECAT system, it reports a communication failure. If the ECAT system is turned on, the FiberCom link between the Windows computer and the ECAT system may be disconnected or improperly installed. Review the installation procedure given in the previous chapter. If the problem persists, contact KeyTek before proceeding. Do not use the simulation option for this procedure.

---

6. Confirm that the list of modules displayed in the *About...* box matches what is installed in the ECAT system.
7. Click *OK*. The SurgeWare window appears as shown in Figure 4-7

Refer to the SurgeWare window shown in Figure 4-7 and continue:

8. In the voltage group, locate the slider control marked *Voltage*.
9. Click on the right and left arrows at the sides of the control and notice that the setting for *Voltage* changes.
10. In the Surge group, pull down the list box labeled *Network* by single clicking on the down arrow at the right side of the box. Confirm that the list box displays the model number of each surge network present. Single click on the first network in the list to select it.
11. Single click the *Run* button, and wait until SurgeWare reports the test is completed. Click *OK* and confirm that the *Active Module* light for the selected network turns on. The *Active Module* light does not go on until after *Run* is clicked.

12. If there is more than one surge network present, select each one in turn and click *Run* and *OK* as in the preceding step. Confirm that the *Active Module* light goes on for each surge network as it is selected.

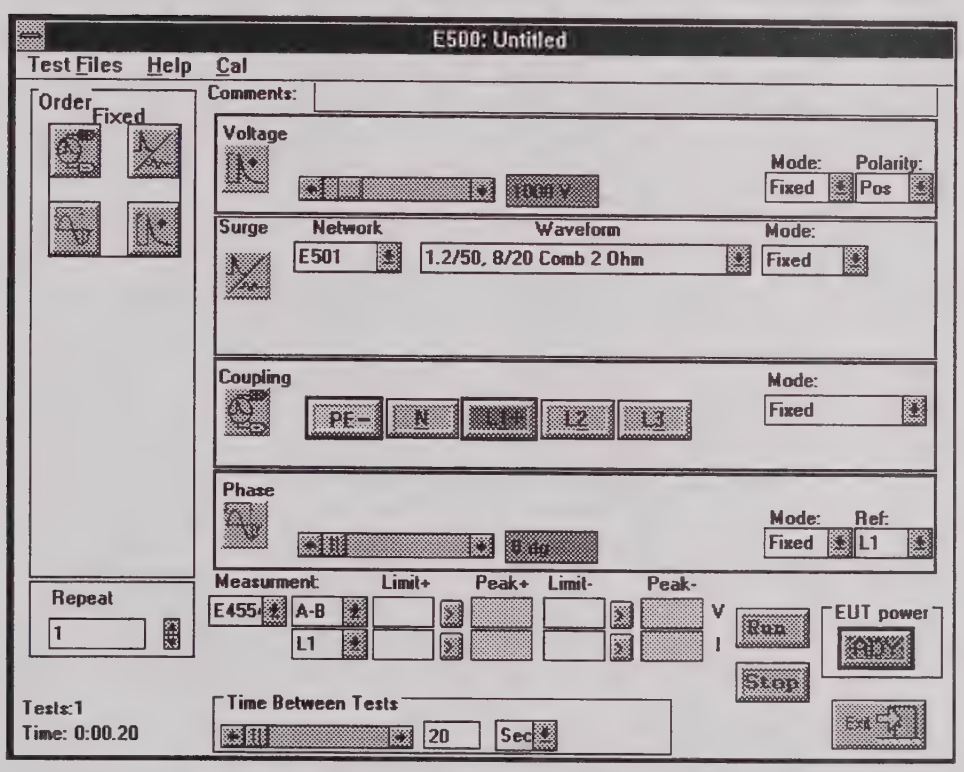

Figure 4-7. SurgeWare Display

If a coupler/decoupler is not present, skip the next two steps.

13. In the Coupling group, pull down the *Mode* list box and select *Fixed*. Portions of the SurgeWare screen change in response to the change in test setup.
14. Click *Run* and wait until SurgeWare confirms that a test has completed. Click *OK* and confirm that the *Active Module* indicator for the selected coupler/decoupler turns on.
15. Click the *Exit* button, and then click *OK* in the dialog box to shut down SurgeWare.

This completes the SurgeWare familiarization.

Microsoft Windows Software Familiarization, BurstWare

To become familiarized with BurstWare, start with the ECAT system turned off. Be sure that there are no external connections to the output connectors of any EFT source or coupler/decoupler.

1. Turn on the ECAT System.
2. If the computer where BurstWare is installed is not turned on, turn it on and bring up Microsoft Windows in the customary fashion.
3. If the program group labeled *KeyTek Control* is not already open, open it by double clicking on the group icon.

Start up BurstWare as follows:

4. Double click on the BurstWare icon. BurstWare displays the *About...* dialog box listing all the modules installed in the ECAT system.

Note

If BurstWare is unable to connect to the ECAT system, it reports a communication failure. If the ECAT system is turned on, the FiberCom link between the Windows computer and the ECAT system may be disconnected or improperly installed. Review the installation procedure given in the previous chapter. If the problem persists, contact KeyTek before proceeding. Do not use the simulation option for this procedure.

---

5. Confirm that the list of modules displayed in the *About...* box matches what is installed in the ECAT system.
6. Click *OK*. The BurstWare window appears as shown in Figure 4-8.
7. Single click the *Run* button, and wait for BurstWare to report the test is complete. Click *OK* and confirm that the *Active Module* light for the EFT/Burst source turns on.

If a coupler/decoupler is not present, skip the next step.

8. In the Coupling group, pull down the *Mode* list box and select *Fixed*. Portions of the BurstWare screen change in response to the change in test setup.

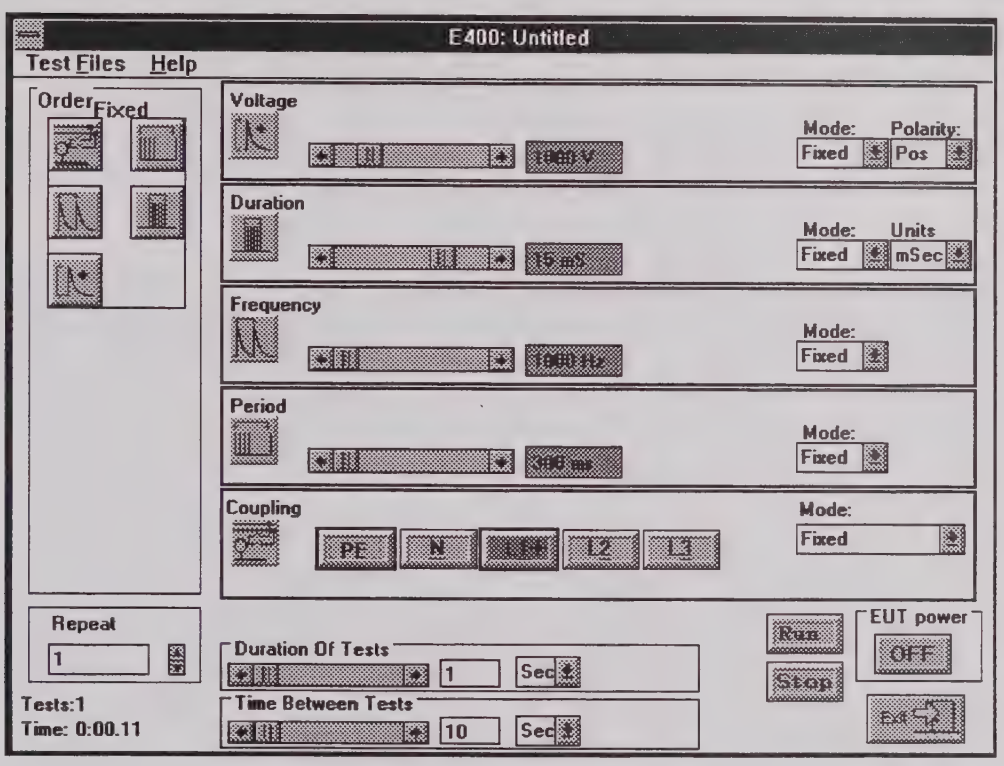

Figure 4-8. BurstWare Display

9. Click *Run* and wait for BurstWare to confirm that a test has completed. Click *OK* and confirm that the *Active Module* indicator at the coupler/decoupler turns on.
10. Click the *Exit* button, and then click *OK* in the dialog box to shut down BurstWare.

Microsoft Windows Software Familiarization, PQFWare

To become familiarized with PQFWare, start with the ECAT system turned off. Be sure that there are no external connections to the output connectors to the PQF module.

1. Turn on the ECAT System.
2. If the computer where PQFWare is installed is not turned on, turn it on and bring up Microsoft Windows in the customary fashion.
3. If the program group labeled *KeyTek Control* is not already open, open it by double clicking on the group icon.

Start up PQFWare as follows:

4. Double click on the PQFWare icon. PQFWare displays the *About...* dialog box identifying the modules installed in the ECAT system.

Note

If PQFWare is unable to connect to the ECAT system, it reports a communication failure. If the ECAT system is turned on, the FiberCom link between the Windows computer and the ECAT system may be disconnected or improperly installed. Review the installation procedure given in the previous chapter. If the problem persists, contact KeyTek before proceeding. Do not use the simulation option for this procedure.

---

5. Confirm that the list of modules displayed in the *About...* box matches what modules are installed in the ECAT system. Click *OK*. The PQFWare window appears as shown in Figure 4-9.

Refer to the PQFWare window shown in Figure 4-9 and continue:

6. Locate the Test Plan window near the center of the display. The plan shows a *Start of List* marker but contains no test entries.
7. Near the bottom of the display, locate the push button marked *Insert After*. Click on the button, a single test step appears in the test list. The properties of the new step depend on the settings in the *Edit* group just above the push buttons; upon start-up, the default item setting is a 10 second short circuit.
8. Locate the *EUT Power* button near the lower left corner of the screen. Click on the button; the legend changes to *RDY*.
9. Press the *EUT Mains* switch on the ECAT System control center. The blue indicator in the switch turns on.

10. Locate the *Activity* group of controls and click on the radio button marked *Test*.
11. *Run* and *Stop* push buttons appear beneath the Activity group and parts of the display change. Click the *Run* button.
12. The *Time Left* display appears at the bottom of the screen and begins counting down.
13. Click the *Exit* button in *PQFWare,* and then click *NO* in the dialog box to shut down PQFWare.

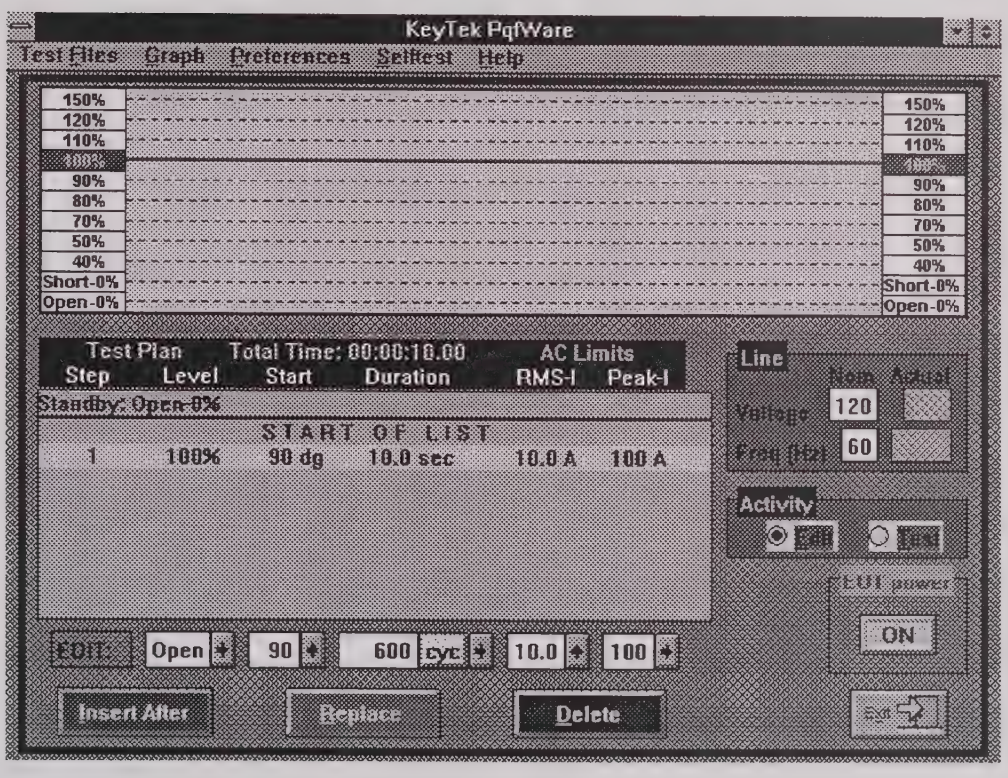

Figure 4-9. PQFWare Display

Performing Simple Surge Tests

This procedure is used for setting up and measuring open and short circuit surges using the internal measurement capability and an external oscilloscope. Procedures are given for both the Virtual Front Panel and SurgeWare. The test shown is specific to the E501 Surge Network and the E551 Coupler/decoupler. The measuring setup assumes the use of a Hewlett Packard Model 54510 or a Tektronix Model 2432 Digital Oscilloscope. For a different surge network, coupler/decoupler or scope, adapt the procedures as necessary.

This procedure includes:

- Wiring the voltage monitor input connections
- Setting up and running the open circuit and short circuit surge tests (both from VFP and SurgeWare)
- Setting up a digital oscilloscope to measure surge waveforms
- Demonstrating EUT power mains control from the surge test menus
- Synchronizing the surge waveform to the AC lines

Wiring the Measurement Inputs

1. Turn off the ECAT System.
2. Locate the clear plastic door covering the surge output terminals of the E551 surge network. Open the door by pressing the latch to the right and pulling the door forward.
3. Select two short banana plug jumpers supplied with the instrument.
4. Jumper the voltage measurement connectors on the coupler/decoupler as shown in Figure 4-10.
5. Close and latch the clear plastic cover.

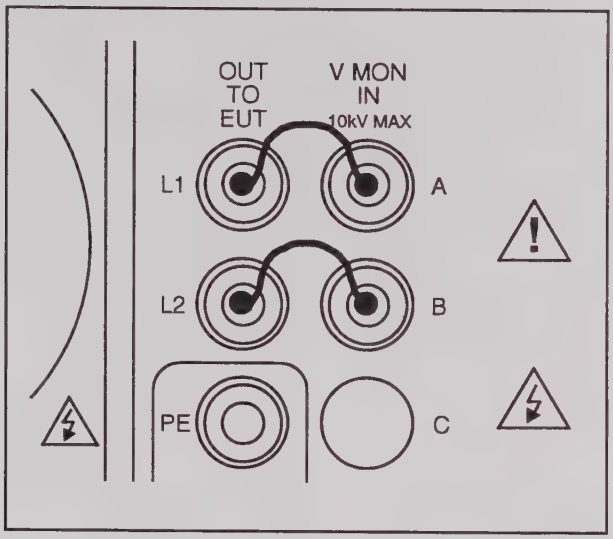

Figure 4-10. Voltage Measurement Jumpers

Open Circuit Surge Test

Setting Up the Scope to Measure Open Circuit Voltage

1. Connect well shielded coax cable such as RG55 between the Channel 1 input on the scope and the *V Mon* BNC connector on the ECAT system control center.

Table 4-1. Scope Setup - Measure Open Circuit Voltage

Tektronix Model 2432		Hewlett Packard Model 54510	
Vertical controls setup			
Gain	1 Volt/division	CHAN	1 on
Baseline	3 divisions below centerline	Probe	1000:1
Mode	CH1- on		1.0 kV/division
	CH2- off	Offset	3.0 kV
	Add, Mul- off		DC
	YT | XT- YT		1 MΩ
Coupling/Invert	CH1- DC		
	50 Ω- off		
	Invert- off		
Horizontal controls setup			
Seconds/division	50 µs/division	TIMEBASE	50 µs/division
		Delay	-50 µs
Trigger position	2nd division from left edge of scope	Reference	Left
			Realtime
Triggering controls setup			
Mode	Normal	TRIG	Trig'd
Source	CH1		Edge
CPLG (coupling)	DC		Source 1
SLOPE	+		Level 2.0 kV
Level	2 Volts approx. (i.e., 2-3 div.)		⎍
			Noise reject off
Acquire mode setup			
Normal[a]		Running- Awaiting Trigger[b]	

[a] If the *Trigger Ready* indicator is not lit, press the *Acquire* button to enable triggering.
[b] If not *awaiting trigger*, press *Single* on the Scope.

Open Circuit Surge Test Using the Virtual Front Panel

Set up the Surge Test

1. Power up the system and wait for the self test to finish.
2. Press F1 to display the Surge Test menu. Select the *Voltage* field.
3. Press *CE* on the numeric keypad to clear the field. Key in the digits *6 0 0 0* and then press *Enter* to lock in the new value.
4. Check the left field of *Network*. If it does not show the model number of the coupler/decoupler, select the field and then repeatedly press *Enter* until it does.
5. Check the field *Output at*. If it does not show *E551*, select the field and change it to *E551*.

Set up the Measurements

1. Press F7 to display the Measurement menu.
2. Check the field of *Measurement Source*. If it does not show the model number of the coupler/decoupler, select the field and enter the model number.
3. Press *Menu* to return to the Surge Test menu.

Verify Interlocks and Fire the Surge

1. The Surge Test menu should still be showing. If it is not, press *Menu*. The status area at the top of the VFP display shows the message *Idle*.
2. Press F1 to begin charging the high voltage supply. The status area at the top of the VFP display shows the message *Charging* while voltage is building up. The display changes to *Ready* and there is an audible "beep" when charging is complete.
3. Wait ten seconds. Since this is the charge hold limit, the high voltage charge is dissipated internally. The status area of the display changes back to the message *Idle*.
4. Press F1 to charge the system again. Wait for the status area to display *Ready*.
5. Open the clear plastic door of any module except the E000 blank module. This breaks the interlocks and immediately dissipates the high voltage charge internally. A warning message appears on the display.

6. Close the door. The warning message is erased, and the Surge Test menu reappears. The status area displays the message *Idle*.
7. Press F1 to charge the system again. Wait for the beep and for the status area to display *Ready*.
8. Press F3 to fire the surge. A trace similar to that shown in Figure 4-11 should be captured on the scope.

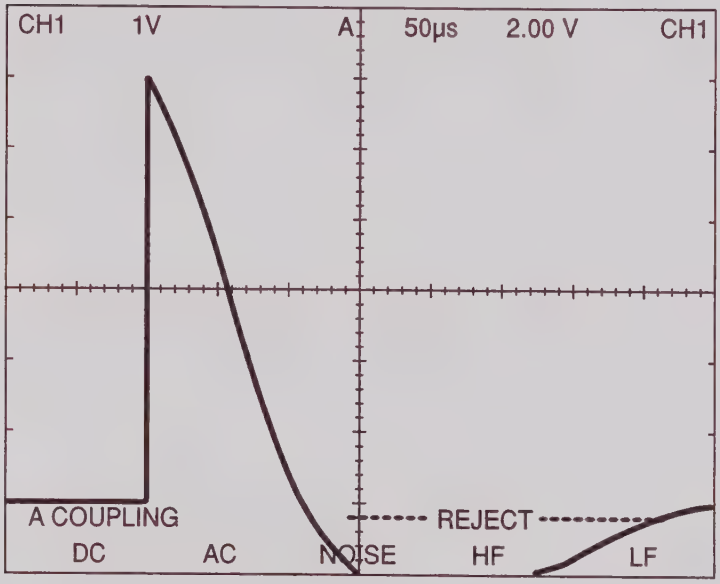

Figure 4-11. Open Circuit Voltage Waveforms

Open Circuit Surge Test Using SurgeWare

Set up the Surge Test

1. In the SurgeWare window, locate the *Surge* control group.
2. If the pull-down list box marked *Network* does not display *E501*, click on the down-arrow at the right of the box and then select *E501* from the list.
3. Locate the *Voltage* group.
4. Drag the slider control to the right until 6000 appears in the adjacent value box. Alternately, double click on the value box and type in *6 0 0 0*.
5. Locate the group labeled *Coupling*. If the list box marked *Mode* is not *Fixed*, click on the down-arrow at the right of the box and then select *Fixed*.
6. Click on the button marked *L1* until it shows *L1+*, and is highlighted in purple.
7. Click on the button marked *L2* until it shows *L2-*, and is highlighted in yellow.

Verify Interlocks and Fire the Surge

1. Click the *Run* button. The *State* indicator (near the bottom of the screen) changes to *Charging*. Most surge networks require about 15 seconds to charge up, although certain high energy networks may take longer.
2. While the system is charging, open the clear plastic door of one of the system modules. This breaks the interlocks and immediately dissipates the high voltage charge internally. A warning message appears on the display.
3. Close the door. Click *OK* on the warning message to erase it. SurgeWare displays the *Test interruption* dialog box.
4. Click *Abort Test* and then click *Run* again to resume testing.
5. After fifteen seconds, the status display changes briefly to *Surging*. A trace similar to that previously shown in Figure 4-11 should be captured on the scope.
6. Click *Exit* and then *OK* to shut down SurgeWare.

Short Circuit Surge Test

Wire the Simulator for Short Circuit Surge

1. Open the clear plastic door covering the output banana-jacks and connect a short jumper between the terminals *Out To EUT L1* and *Out To EUT L2* at the coupler/decoupler.

Set Up the Scope to Measure Short Circuit Current

1. Reconnect the coax cable between the Channel 1 input on the scope and the *I Mon* connector on the surge simulator control center.

Table 4-2. Scope Setup - Measure Short Circuit Current

Tektronix Model 2432		Hewlett Packard Model 54510	
Vertical controls setup			
Gain	5 Volt/division	CHAN	1 on
Baseline	2 divisions below centerline	PROBE	200:1
			1.0 kV/division
		OFFSET	2.0 kV
Horizontal controls setup			
Seconds/division	10 µs/division	TIMEBASE	10 µs/division
		DELAY	-10.0 µs
Triggering controls setup			
Level	5 Volts approx. (i.e., 1 div.)	LEVEL	2.0 kV

Short Circuit Surge Test Using the Virtual Front Panel

1. If the Surge Test menu is not visible, repeatedly press *Menu* until it appears. Alternately, if the main ECAT menu appears, press F1 to see the Surge Test menu.
2. Verify that the test setup is exactly as before:
   Voltage: 6000
   Network: *E501 - 2 ohm*
   Output at: *E551*
3. Press F7 to display the Measurement menu.
4. Verify that the measurement setup is exactly as before:
   Measurement Source: *E551*
5. Press *Menu* to return to the Surge Test menu.
6. Press F1 to charge the system. Wait for the status area to display *Ready.*
7. Press F3 to fire the surge. A trace similar to that in Figure 4-12 should be captured on the scope.

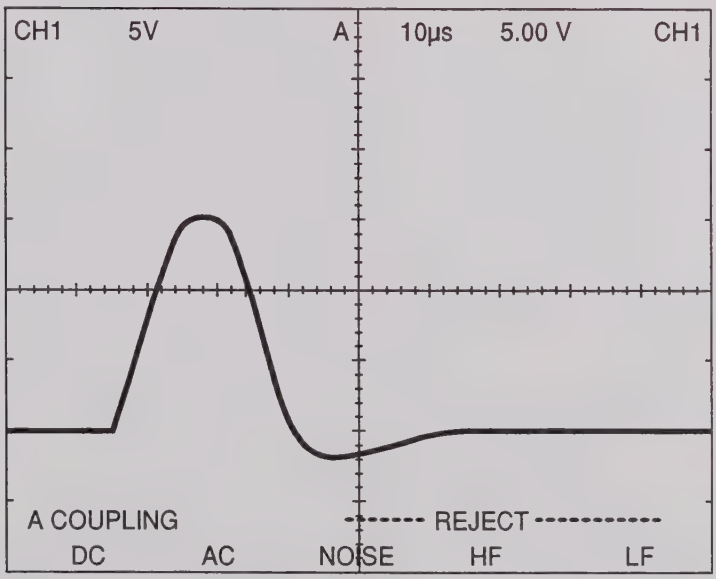

Figure 4-12. Short Circuit Current Waveform

Short Circuit Surge Test Using SurgeWare

1. Start SurgeWare and setup the test exactly as before:

   Voltage: 6000

   Surge Network: *E501 - 2 ohms*

   Coupling Mode: *Fixed: L1+, L2-*

2. Click *Run* to charge the system. After fifteen seconds, the surge fires. A trace similar to that in Figure 4-12 should be captured on the scope.

EUT Mains Control and EUT Power Interlocks Under Surge

1. **Remove the shorting jumper used for the short circuit test.**
2. Plug a standard table lamp into the EUT power outlet of the coupler/decoupler, or wire a light bulb suitable for operation at the AC mains voltage across the output terminals.

   For single phase units, connect the bulb across L1, L2.

   For three-phase coupler/decouplers, connect the bulb as follows:

   Between L1 and L2 if the AC supply to the EUT is a delta circuit

   Between L1 and N if the AC supply is a Y circuit
3. Connect an AC power source to the AC input connector, labeled Test AC Input, of the coupler/decoupler.
4. Cycle the power at the ECAT system by momentarily turning *System Power* off and then back on. This resets all parameters to their defaults.
5. Press the *EUT Mains* switch on the ECAT control center. It latches inward, but the blue indicator does not turn on and the light bulb connected to the coupler/decoupler outputs does not turn on. Leave *EUT Mains* latched inward.

Using the Virtual Front Panel

The keys F1, *Enter*, ↓ and → in the following procedure refer to keys on the Virtual Front Panel. The field *EUT Pwr* is located on the VFP display. The switch *EUT Mains* is located just to the right of the VFP.

1. Press F1 to select the Surge Test menu.
2. Select the field *EUT Pwr* on the display. The value *off* is displayed in the field.
3. Press *Enter*. The value displayed changes to *Ready*.

   Both the blue indicator on the *EUT Mains* switch and the light bulb connected to the coupler/decoupler remain off.
4. Press *EUT Mains* once so that it latches outward in the off position, then press it again so that it latches inward in the on position.

   Both the blue indicator on *EUT Mains* and the light bulb connected to the coupler/decoupler turn on.

5. Verify that the field *EUT Pwr* is still selected on the Virtual Front Panel.
6. Press *Enter*. *EUT Pwr* changes to *off*.

   Both the blue indicator in *EUT Mains* and the light bulb connected to the coupler/decoupler go off.
7. Press *Enter* again. *EUT Pwr* changes back to *Ready*, but the light bulb and the blue indicator in *EUT Mains* remain off.
8. Press *EUT Mains* twice. The blue indicator and the light bulb both turn on, and *EUT Pwr* changes to *on*.
9. Turn *EUT Mains* off.
10. Press *Enter* to turn the field *EUT Pwr* off.

Using SurgeWare

In the following procedure, *EUT Power* refers to a control group that appears in the SurgeWare display window on the PC; the switch *EUT Mains* is located on the control center of the ECAT system.

1. If SurgeWare is running, close the SurgeWare window and restart the program.
2. Locate the control group labeled *EUT Power* near the bottom of the SurgeWare window. The button legend is *off*.
3. Click on the button, the legend changes to *Ready*.

   The blue indicator on the *EUT Mains* switch and the light bulb connected to the coupler/decoupler both remain off.
4. Press the *EUT Mains* switch once so that it latches outward in the off position, then press it again so that it latches inward in the on position. The legend on the button changes to on.

   The blue indicator on *EUT Mains* turns on and the light bulb connected to the coupler/decoupler turns on. The legend on the button *EUT Power* in SurgeWare also changes to *on*.
5. Click on the *EUT Power* button in the SurgeWare control group. The legend changes to *off*. The blue indicator in *EUT Mains* goes off and the light bulb connected to the coupler/decoupler goes off.
6. Click on the *EUT Power* button in the SurgeWare control group again. The legend changes back to *Ready*. Both the light bulb and the indicator in *EUT Mains* remain off.
7. Press the *EUT Mains* switch twice. The legend changes to *on*, and both the blue indicator and the light bulb turn on.
8. Turn *EUT Mains* off.
9. Click on the *EUT Power* button in the SurgeWare control group; the legend changes to *off*.

Surge Line Sync Operation

1. Disconnect the light bulb from the coupler/decoupler output terminals.
2. Connect the Channel 1 input on the scope to the BNC connector marked *V Mon* on the ECAT system.

Table 4-3. Scope Setup - Surge Line Sync Operation

Tektronix Model 2432		Hewlett Packard Model 54510	
Vertical controls setup			
Gain	200 mV/division	CHAN	1 on
Baseline	Middle of the screen	PROBE	1000:1
			200 V/division
		OFFSET	0.00
Horizontal controls setup			
Seconds/division	1 ms/division	TIMEBASE	1 ms/division
		REFERENCE	Center
			Realtime
Trigger position	Middle of the screen	DELAY	4.0 ms
Triggering controls setup			
Level	400 mV, approx. (i.e., 2 div.)	LEVEL	400 V

Using the Virtual Front Panel

1. On the Surge Test menu, set up the following fields:
   Voltage: 500 Volts
   Waveform: *E501*
   Coupling: *L1: HI L2: LO PE: --*
   EUT Power: *Ready*
   Phase Mode: *L1*
   Phase Angle: *0 degrees*
2. On the Measurement menu, verify the setting of one field.
   Measurement source: *E551*
3. Press the *EUT Mains* switch. The blue indicator goes on.

   The scope should not trigger. If necessary, continue to raise the trigger level until the scope does not trigger. Then raise the trigger level slightly higher to prevent false triggering.

4. Press F1 to charge up the high voltage system. Wait until the message displayed in the VFP status area is *Ready.*
5. Press F3 to fire the surge. A trace similar to that shown in Figure 4-13 should be captured on the scope.

   The trace shows the pulse as a narrow spike centered on the zero crossing of the AC sine wave. Because of the time scale used, the entire sine wave is not visible.
6. Repeat this procedure for phase angles of 90 degrees and 270 degrees. The waveform captured on the scope shows the pulse spike superimposed on the (positive or negative) peak of the AC sine wave.

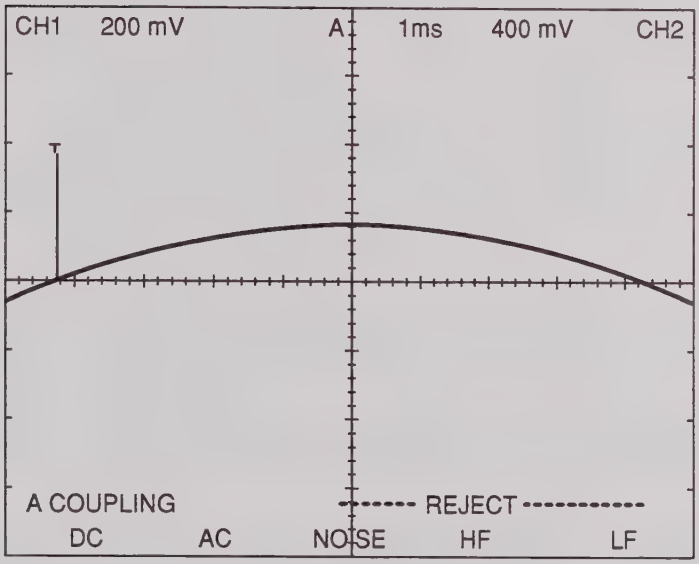

Figure 4-13. Scope Waveform

Using SurgeWare

1. In the SurgeWare window, set up the following fields:

Voltage:	500 volts
Waveform:	*E501*
Coupling Mode:	*Fixed, L1+ L2-*
Phase:	0 degrees

2. The push button displayed in the group *EUT Power* should be labeled *off*.
3. Click on that button; the legend changes to *Ready*.
4. Press the *EUT Mains* switch. The blue indicator goes on.

   The scope should not trigger. If it does, raise the trigger level a bit and reset the scope. If necessary, continue to raise the trigger level until the scope does not trigger.
5. Click *Run* to charge up the high voltage system and fire the test. It takes fifteen seconds for the system to charge up before the surge is fired.

   A trace similar to that shown in Figure 4-13 should be captured on the scope.

   The trace shows the pulse as a narrow spike centered on the zero crossing of the AC sine wave. Because of the time scale used, the entire sine wave is not visible.
6. Repeat this procedure for phase angles of 90 degrees and 270 degrees. The waveform captured on the scope shows the pulse spike superimposed on the (positive or negative) peak of the AC sine wave.

Performing Simple PQF Tests

This procedure demonstrates two PQF setups. It illustrates how to use the internal measurements capabilities of the PQF module and how to display the resultant waveform on an oscilloscope.

Procedures are given for both the Virtual Front Panel and PQFWare. The test shown is specific to the EP61 PQF source. The measuring setup assumes the use of a Tektronix Model 2432 Digital Oscilloscope or a Hewlett Packard Model 54510. For a different source or scope, you should adapt the procedures as necessary.

Generating a Simple Notch Waveform

This setup produces an AC power source with low voltage notches of 10 degree duration at 90 degrees and 270 degrees.

Set up the Oscilloscope

1. Connect well shielded coax cable, such as RG55, between the Channel 1 input on the scope and the V Mon BNC connector on the ECAT system control center.

Table 4-4. Scope Set Up - Simple Notch Waveform

Tektronix Model 2432		Hewlett Packard Model 54510	
Vertical controls setup			
Gain	100 mV/division	CHAN	1 on
Baseline	Middle of the screen	PROBE	1000:1
Mode	CH1- on		100 V/division
	CH2- off	OFFSET	0.00
	Add, Mul- off		DC
	YT | XT- YT		1MΩ
Coupling/Invert	CH1- DC		
	50 Ω- off		
	Invert- off		
Horizontal controls setup			
Seconds/division	2 ms/division	TIMEBASE	2 ms/division
Trigger position	1st division from left edge of scope	REFERENCE	Left
		DELAY	2 ms
			Realtime
Triggering controls setup			
Mode	Normal	TRIG	Trig'd
Source	LINE		Edge
CPLG (coupling)	DC		Source 1
SLOPE	+		Center
Level	200 mV, approx. (i.e., 2 div.)	NOISE REJ	on
Acquire mode setup			
Normal[a]		Running- Awaiting Trigger[b]	

[a] If the *Trigger ready* indicator is not lit, press the *Acquire* button to enable triggering.
[b] If not *awaiting trigger*, press *Single* on the Scope.

Running the Test From the Virtual Front Panel

To generate a continuous waveform with two notches, a five test-step sequence is needed.

1. Power up the system if necessary and wait for the self test to finish. If the message *Remote* appears, press *Menu* to remove it.
2. Verify that the *EUT Mains* switch is latched outward in the off position.
3. Press F7 to display the PQF menu.
4. Press F1 five times to insert five test steps.
5. Press F2 to insert a *GoTo 1* step.
6. Press ↑ several times. The reverse-video cursor steps vertically through the steps in the test list. Select step 1.
7. Press → or ←, if necessary, to position the cursor in the column marked *% LVL*.
8. Repeatedly press the *Enter* key until the value 100 appears.
9. Move to the column *Start Ang*. Press *CE*, then 0 and *Enter*.
10. Move to the column *Step Duration*. Press *CE*, then 0 and *Enter*.
11. Press ↓ to select step number 2.
12. Set *% LVL* to *Short*, *Start Angle* to 90 and *Step Duration* to 0.
13. Press ↓ to select step number 3.
14. Set *% LVL* to 100, *Start Angle* to 100 and *Step Duration* to 0.
15. Press ↓ to select step number 4.
16. Set *% LVL* to 50, *Start Angle* to 270 and *Step Duration* to 0.
17. Press ↓ to select step number 5.
18. Set *% LVL* to 100, *Start Angle* to 280 and *Step Duration* to 0.
19. Press *Start* to start the test. Because EUT power is not Enabled, the message *Error: EUT Power is not requested* appears.
20. To clear the message, press F6: *Abort*.
21. Press F4 to enable EUT power.
22. Press the *EUT Mains* switch on the ECAT control center. Both the blue *EUT Mains* indicator and the amber *Voltage Present* indicator on the PQF module turn on.
23. Press *Start* to begin the test. A waveform similar to that shown in Figure 4-14 appears on the oscilloscope.
24. Press F5 to stop the test, and turn off the *EUT Mains* switch.

Running the Test From PQFWare

1. Power up the system if necessary and wait for the self test to finish.
2. Verify that the *EUT Mains* switch is latched outward in the off position.
3. Start up PQFWare on the Microsoft Windows computer. The Virtual Front Panel should display the message *Remote*.

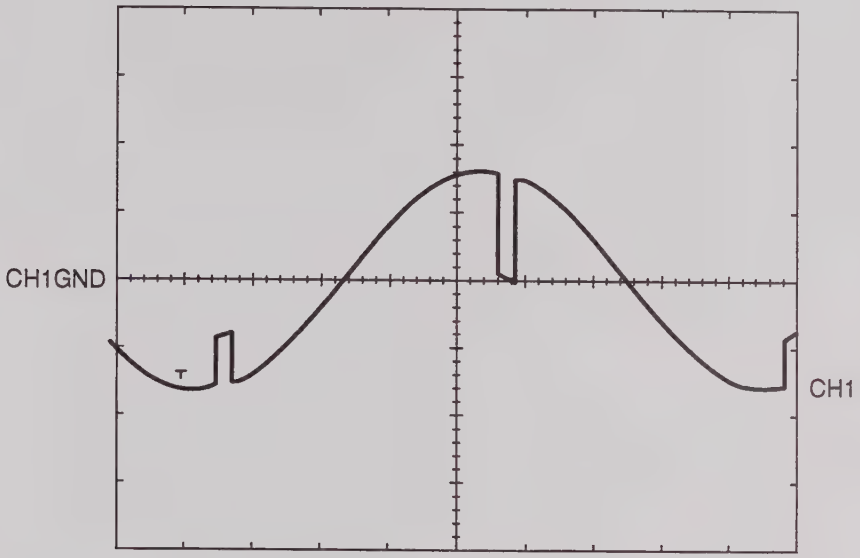

Figure 4-14. Scope Waveform, PQF Notch

4. Verify that the EP61 or EP62 model number appears in the *Modules Loaded* portion of the *About...* screen.
5. Click *OK* to clear the *About...* screen.
6. Locate the test controls, marked *Edit*, just above the push buttons at the bottom of the display. There are five edit controls, corresponding to columns in the *Test Plan* window marked *Level*, *Start*, *Duration*, *RMS-I* and *Peak-I*. This setup ignores the settings for *RMS-I* and *Peak-I*.
7. Click on the small arrow just to the right of the edit control for *Level*. A slider control appears.
8. Move the slider to the right until the value 100 appears. Click once on the number 100 to put away the slider control.
9. Double click on the value displayed in the edit control for *Start*. The current value becomes highlighted.
10. Type in the new value 0. The new value replaces the old one.
11. Double click on the value displayed in the edit control for *Duration*. The current value becomes highlighted.
12. Type in the new value 0. The new value replaces the old one.
13. If the label to the right of the *Duration* value is not *Cyc* (for cycles), single click on it until it changes to *Cyc*.
14. Click *Insert after* to insert the first test step.
15. Change *Level* to *Short*.
16. Change *Start* to 90.

17. Click *Insert after* to insert the second step.
18. Change *Level* to 100 and *Start* to 100 and insert step 3.
19. Change *Level* to 50 and *Start* to 270 and insert step 4.
20. Change *Level* to 100 and *Start* to 280 and insert step 5.
21. In the *Activity* group on the right side of the display, click on the radio button marked *Test*.
22. Click the *Repeat test* button, lower left corner of the display, so that it is *on*.
23. Click on the *Run* button to start the test. Nothing happens, because the EUT power is not enabled; PQFWare displays an error message.
24. Click *OK* to clear the error message.
25. Click the *EUT Mains* button in the PQF window, and confirm that it shows *Ready*.
26. Turn on the blue *EUT Mains* switch on the ECAT control center. Both the blue indicator and the amber *Voltage Present* indicator on the PQF module turn on.
27. Click *Run* to start the test. The button color changes to green, and a waveform similar to that previously shown in Figure 4-14 appears on the oscilloscope.
28. Click the *Stop* button and press *EUT Mains* to return it to its off position (latched outward).
29. Click the *Exit* button in PQFWare, and click *No* in the dialog box to shut down PQFWare.

Generating a Simple Sag Waveform

This setup produces an AC power source with a 50% sag in voltage that lasts for ten cycles and repeats every 200 ms.

Set up the Oscilloscope

Use settings given for the previous setup, and change:

Tektronix Model 2432		**Hewlett Packard Model 54510**	
Horizontal controls setup			
Seconds/division	50 ms/division	Time Base	50 ms/division

Run the Test From VFP

A two test step sequence is used to generate a continuous 200 ms output waveform having ten AC cycles at 50% voltage followed by a return to 100% line voltage for two cycles.

1. Power up the system if necessary and wait for the self test to finish. If the message *Remote* appears, press *Menu* to remove it.
2. Verify that the *EUT Mains* switch is latched outward in the off position.
3. Press F7 to display the PQF menu.
4. Press F1 two times to insert two test steps.
5. Press F3 to insert a *GoTo 1* step.
6. Press ↑ several times. to select step 1.
7. Set *% LVL* to 50, *Start Angle* to 0 and *Step Duration* to 10 *Cycles*.
8. Press ↓ to select step 2.
9. Set *% LVL* to 100, *Start Angle* to 0 and *Step Duration* to 2.
10. Set the units for *Step Duration* to *Cycles*.
11. Press F4 to enable EUT power.
12. Turn on the *EUT Mains* switch.
13. Press *Start* to start the test. A waveform similar to that shown in Figure 4-15 appears on the oscilloscope.
14. Press *Stop* to stop the test.
15. Turn off the *EUT Mains* switch.

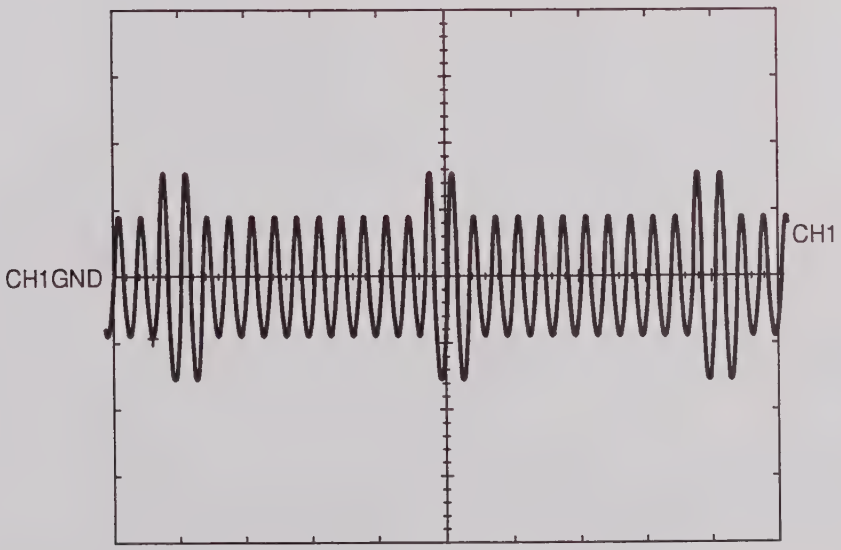

Figure 4-15. Scope Waveform, PQF Voltage Sag

Run the Test From PQFWare

1. Power up the system if necessary and wait for the self test to finish.
2. Verify that the *EUT Mains* switch is latched outward in the off position.
3. Start up PQF Ware on the Windows computer. The Virtual Front Panel should display the message *Remote.*
4. Click *OK* to clear the *About...* screen.
5. Locate the test step edit controls just above the push buttons at the bottom of the display. There are five controls; each corresponds to one column in the Test Plan window: *Level, Start, Duration, RMS-I* and *Peak-I*. For this setup, ignore the settings for *RMS-I* and *Peak-I*.
6. Set *Level* to 50, *Start* to 0, and *Duration* to 10 *Cyc*.
7. Click *Insert after* to insert the first step.
8. Change *Level* to 100, *Start* to 0 and *Duration* to 2 *Cyc*.
9. Click *Insert after* to insert step 2.
10. In the *Activity* group on the right side of the display, click on the radio button marked *Test*.
11. Click the *Repeat test* button at the lower left corner of the display so that it is *on*.
12. Click the *EUT Power* button so that it displays *Ready.*
13. Press the blue *EUT Mains* switch on the ECAT control center, the blue indicator turns on.
14. Click the *Run* button to start the test. A waveform similar to that previously shown in Figure 4-15 appears on the oscilloscope.
15. Click the *Stop* button and press *EUT Mains* to return it to its off position (latched outward).
16. Click the *Exit* button in the PQFWare window and click *No* in the dialog box to shut down PQFWare.

Performing a Simple EFT/Burst Test

These procedures demonstrate how to set up the EFT/Burst simulator and view the resulting waveforms three different ways. Procedures are given both for the Virtual Front Panel and for BurstWare. The test setup described is specific to the Model E411 EFT/Burst source.

Individual EFT pulses are very narrow, 50 ns. This makes them difficult to capture and display on an oscilloscope. This is particularly true since it is often desirable to view a burst of pulses or even several bursts, where the time between pulses in a burst is several orders of magnitude longer than the width of an individual pulse.

In order to view the timing sequences, an oscilloscope with an envelope display feature is required. The scope setup given here is specific to the Tektronix Model 2432 Digital Oscilloscope.[2] Hewlett Packard has also announced products with this feature, but a unit was not available as of this writing.

These procedures illustrate the effect of varying the capture parameters of the scope to separately display the frequency, period and duration of a single EFT/Burst pulse train. All of the setups use the glitch triggering capability of the 2432 scope.

Setting up the EFT/Burst Test

From the Virtual Front Panel

1. Power up the system if necessary and wait for the self test to finish. If the message *Remote* appears, press *Menu* to remove it.
2. Verify that the *EUT Mains* switch is latched outward in the off position.
3. Press F3 to display the EFT/Burst menu.
4. Select the field marked *Output at*. If the value of the field is not *Out1*, press the *Enter* key so that *Out1* appears.
5. Press → to select *Mode*. If *Mode* is not *Con* (continuous) press the *Enter* key so that *Con* appears.
6. Select the *Voltage* field.
7. Press *CE* and then enter *1 0 0 0* followed by *Enter* to set the output voltage to 1000 volts.
8. Set *Chirp* to *off* (or N/A).
9. Set *Frequency* to 5 kHz.
10. Set *Duration* to 15 pls.
11. Set *Period* to 300 ms.

From BurstWare

1. Power up the ECAT system if necessary and wait for the self test to finish.
2. Verify that the *EUT Mains* switch is latched outward in the off position.
3. Start up BurstWare on the Windows computer. The Virtual Front Panel should display the message *Remote*.
4. In the *Voltage* group of controls, verify that the *Voltage* is set to 1000 volts, and *Mode* is *Fixed*; if not, change the controls as needed.
5. In the *Duration* group of controls, verify that *Duration* is 15 ms and that *Mode* is *Fixed*; if not, change the controls as needed.

---

[2] The Tektronix 2432 does not have sufficient bandwidth to precisely capture individual 5 ns pulses as generated by the EFT/Burst source; however, it does have sufficient bandwidth to capture and view the overall pulse *train*.

6. In the *Frequency* group of controls, set *Frequency* to 5000 Hz and verify that *Mode* is *Fixed*.
7. In the *Period* group of controls, verify that *Period* is 300 ms and that *Mode* is *Fixed*.
8. In the *Coupling* group of controls, verify that *Mode* is *E411 Out1*.

Three Oscilloscope Setups

Three test setups are described here to:

- Observe the Frequency of Pulses in a Burst
- Observe Duration of a Burst
- Observe the Burst to Burst Period

To Observe Frequency of Pulses in a Burst

1. Connect well shielded coax cable such as RG55 between the Channel 1 input on the scope and the V Mon BNC connector on the EFT/Burst source.

Table 4-5. Scope Setup - EFT/Burst - Observe Frequency of Pulses

Tektronix Model 2432	
Vertical controls setup	
Gain	200 mV/division
Baseline	3 divisions below centerline
Mode	CH1- on
	CH2- off
	Add, Mul- off
	YT | XT- YT
Coupling/Invert	CH1- DC
	50 Ω- on
	Invert- off
Horizontal controls setup	
Seconds/division	50 µs/division
Trigger position	2nd division from left edge of scope

Table 4-5. Scope Setup - EFT/Burst - Observe Frequency of Pulses *continued*

Tektronix Model 2432	
Triggering controls setup	
Mode	Normal
Source	CH1
CPLG (coupling)	DC
SLOPE	+
Level	400 mV (approx. 2 divisions)
Acquire mode setup	
Envelope[a]	1

[a] If the *Trigger ready* indicator is not lit, press the *Acquire* button to enable triggering.

2. Press *Run* on the VFP or click the *Run* push button. The waveform shown in Figure 4-16 appears on the scope.
3. Press *Stop* to end the test.

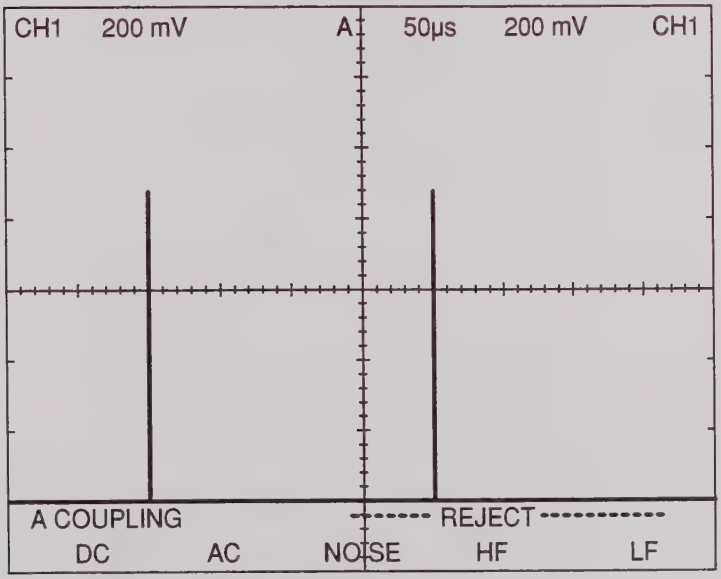

Figure 4-16. Scope Waveform, Frequency Test

To Observe Duration of a Burst

1. Connect well shielded coax cable such as RG55 between the Channel 1 input on the scope and the *V Mon* BNC connector on the EFT/Burst source.

Table 4-6. Scope Setup - EFT/Burst - Observe Duration of a Burst

Tektronix Model 2432	
Vertical controls setup	
Gain	200 mV/division
Baseline	3 divisions below centerline
Mode	CH1- on
	CH2- off
	Add, Mul- off
	YT | XT- YT
Coupling/Invert	CH1- DC
	50 Ω- on
	Invert- off
Horizontal controls setup	
Seconds/division	2 ms/division
Trigger position	2nd division from left edge of scope
Triggering controls setup	
Mode	Normal
Source	CH1
CPLG (coupling):	DC
SLOPE	+
Level	400 mV (approx. 2 divisions)
Acquire mode setup	
Envelope[a]	1

[a] If the *Trigger ready* indicator is not lit, press the *Acquire* button to enable triggering.

2. Press *Run* on the VFP or click the *Run* push button. The waveform shown in Figure 4-17 appears on the scope.
3. Press *Stop* to end the test.

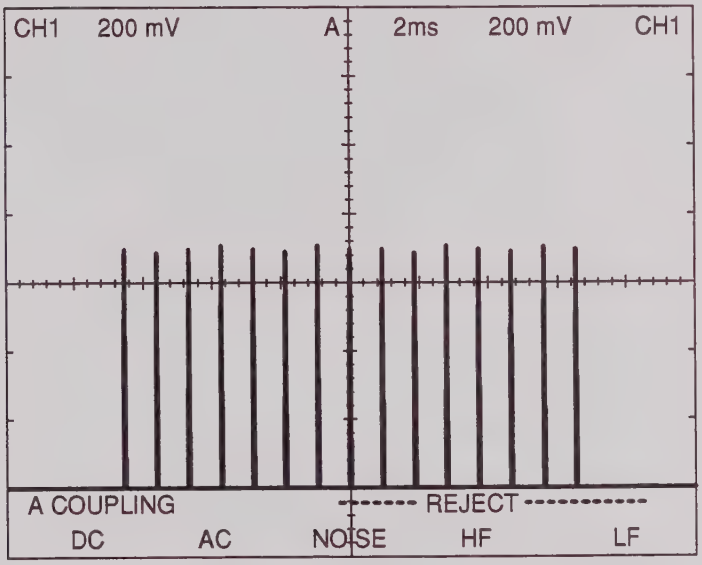

Figure 4-17. Scope Waveform, Duration Test

To Observe Burst to Burst Period

1. Connect well shielded coax cable, such as RG55, between the Channel 1 input on the scope and the *V Mon* BNC connector on the EFT/Burst source.

Table 4-7. Scope Setup - EFT/Burst - Observe Burst to Burst Period

Tektronix Model 2432	
Vertical controls setup	
Gain	200 mV/division
Baseline	3 divisions below centerline
Mode	CH1- on
	CH2- off
	Add, Mul- off
	YT | XT- YT
Coupling/Invert	CH1- DC
	50 Ω- on
	Invert- off
Horizontal controls setup	
Seconds/division	50 ms/division
Trigger position	1st division from left edge of scope
Triggering controls setup	
Mode	Normal
Source	CH1
CPLG (coupling)	DC
SLOPE	+
Level	400 mV (approx. 2 divisions)
Acquire mode setup	
Envelope[a]	1

[a] If the *Trigger ready* indicator is not lit, press the *Acquire* button to enable triggering.

2. Press *Run* on the VFP or click the *Run* push button. The waveform shown in Figure 4-18 appears on the scope.
3. Press *Stop* to end the test.

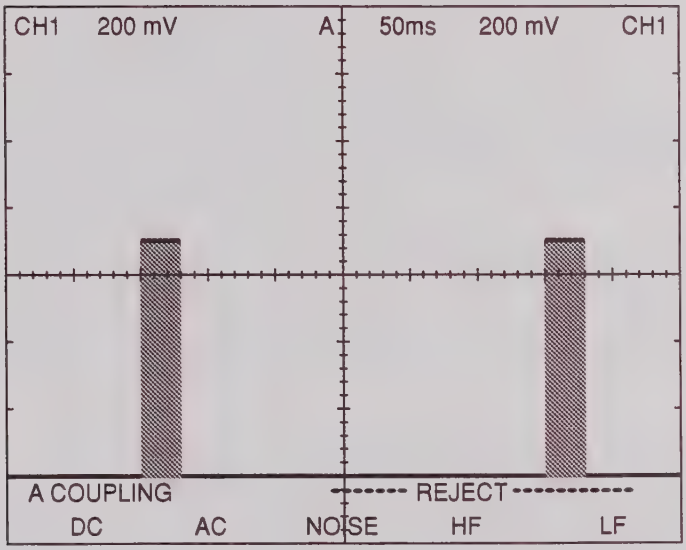

Figure 4-18. Scope Waveform, Burst to Burst Period Test

Chapter 5
Operating the ECAT System

The photograph in Figure 5-1 shows the instrument Control Center, the Virtual Front Panel (VFP) and an external PC running the ECAT SurgeWare software. The Control Center is standard on all systems. The Virtual Front Panel and Microsoft Windows-based software are options: one must be present, but both may be installed on the same system.

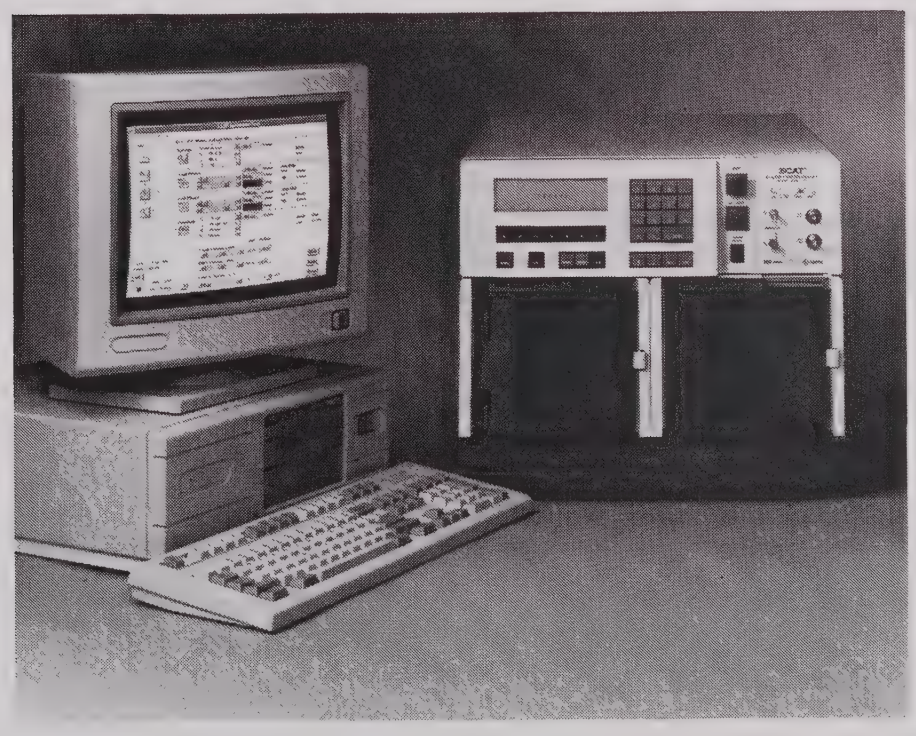

Figure 5-1. Control Center, Virtual Front Panel, and PC-based SurgeWare

The Control Center is used in all testing scenarios. It includes power controls, safety interlocks, coaxial voltage and current monitor output connectors,[1] and an emergency shutdown switch.

The Virtual Front Panel is used primarily for manual operations and is ideal for setting up single-shot surge tests and simple iterative sequences. It is often used in concert with SurgeWare for quick test runs.

The Microsoft Windows software controls the ECAT system from an external PC running Microsoft Windows 3.x[2]. It provides access to all ECAT functions and offers total control of the simulator. The software includes three main programs:

- SurgeWare for surge testing
- PQFWare for power quality testing
- BurstWare for electrical fast transient testing

These programs are used to setup and run single-shot surge tests as well as complex test suites. Some functions available under these programs are not available via the Virtual Front Panel.

The software provides complete facilities for storing test sequences and recalling them for future use. This ability to set up complex test sequences is the hallmark of ECAT. Sequences may consist of several individual preset tests strung together, or may be defined to span a range of values in linear or logarithmic steps. Various approaches may be combined in a single test sequence.

Within a sequence, you can vary one or more parameters with complete control over how the parameters change and in what order. You may also specify the number of times a test or a portion of a test is to repeat, and then define the order in which the repetitions take place. Sequences can be stored on disk and then be rerun or modified at any time.

Understanding the Control Center

The control center is shown in Figure 5-2. It includes the *System Power* switch, an *EUT Mains* control for the equipment under test, a *Stop* button intended for emergency shutdown of the entire system, Voltage and Current Monitor connectors, and a pair of FiberLoop connectors.

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1. Voltage and Current monitor connectors are inactive if the V and I Monitor option is not installed.
2. Windows 3.x refers to Microsoft Windows™, Version 3.1 and later.

Stop - Emergency shutdown switch. Press this switch to power down the instrument in the event that all testing and EUT power must be shut down instantly. Any existing high voltage charge in the system is rapidly dissipated. In addition, any mains power supplied from a module will be interrupted.

Pull the switch out to reset it and to restore power. If *EUT Mains* was *On*, EUT power remains switched off until *EUT Mains* is recycled, as described in more detail below. This switch is not intended to be used as the primary power switch.

System Power - Controls AC mains power to the instrument. When this switch is off, power throughout the instrument is off. All mains power supplied to an EUT through coupler/decouplers is also off.

When this switch is on, AC power is supplied to the system only if the *Stop* switch is in the reset position (i.e., pulled out). If *EUT Mains* is in the *On* position, EUT power remains switched off until *EUT Mains* is recycled, as described in more detail below.

Upon power up, the instrument performs a self test and then enables the system control menus. If a VFP is installed, a progress monitor is displayed while the self test is running.

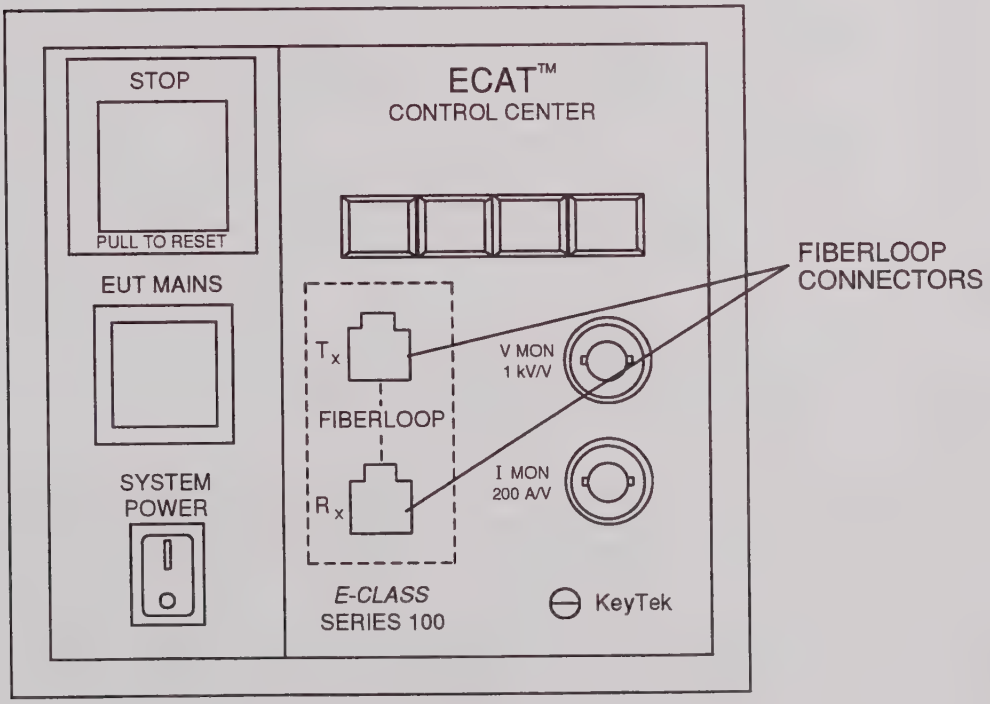

Figure 5-2. Control Center

EUT Mains - This switch controls power to an EUT supplied through a PQF source or a coupler/decoupler. It is a two-position switch (it latches inward) with a blue light that indicates when power is switched on to the EUT.

For safety reasons, *EUT Mains* is overridden by several other controls in the system:

- *System Power* must be on *(set to 1)*
- *Stop* must be *Reset* (pulled out)
- *FiberLoop* option (if installed) must form a closed loop (details are given below)
- *EUT Power* control must be *Ready*, either from the VFP or from the Microsoft Windows ECAT software
- All interlocks are closed

EUT Mains is intended to be turned on as the last step in a test setup, after all parameters for the test are defined.

Pressing *EUT Mains* has no effect if any override condition is not met. Furthermore, the loss of any single condition immediately turns off EUT mains power.

If the *EUT Mains* switch is on when EUT mains power is overridden, the blue indicator goes off even though the switch itself remains latched in the on position. After such an override, EUT power is not restored until all overriding conditions are enabled and the *EUT Mains* button is cycled and then latched in the inward position after the override is cleared.

V MON (Voltage Monitor) - This coaxial BNC connector provides a single-ended input to a digital storage oscilloscope or other transient recording instrument. Output is scaled to 1 kV/V for capturing the surge voltage waveform at the selected measurement point.

There are a variety of voltage monitoring sources that can be coupled to this monitor, located in both the active pulsed-EMI source module and the coupler/decoupler. The measurement source is selected during test setup using the Virtual Front Panel or the Microsoft Windows ECAT software.

I MON (Current Monitor) - This coaxial BNC connector provides a single-ended input to a digital storage oscilloscope or other transient recording instrument. Output is scaled to 200 A/V for capturing the surge current waveform at the selected measurement point.

There are a variety of current monitoring sources that can be coupled to this monitor. The measurement source is selected during test setup using the Virtual Front Panel or the Microsoft Windows ECAT software.

T_x and R_x (FiberLoop Connectors) - Two fiberoptic connectors, labeled T_x and R_x, located to the right of the power switches are used for the FiberLoop interlock option. If the option is present and enabled, a fiberoptic shorting jumper must be installed between the connectors.

If the optical path in FiberLoop is broken or not connected, or if any device in the FiberLoop system detects an interlock failure, FiberLoop shuts down EUT Main power and disables and discharges the high voltage supply.

The FiberLoop interlock does not disable controller power.

If *EUT Mains* is in the on position when the interlock opens, EUT power remains switched off until *EUT Mains* is recycled *after* the interlock closes.

If the FiberLoop system is installed but not in use, there must be a fiberoptic jumper (supplied with the instrument) connecting T_x and R_x.

Understanding the Virtual Front Panel

The Virtual Front Panel is shown in Figure 5-3. It allows you to specify pulsed EMI tests in various configurations. Use the Virtual Front Panel to select, set up and control:

- Pulsed EMI source: Surge, PQF or EFT
- Waveform options, including voltage, shape and other properties
- Direct output or Coupler/decoupler (surge, EFT only)
- Network-dependent options (e.g., coupling impedance)

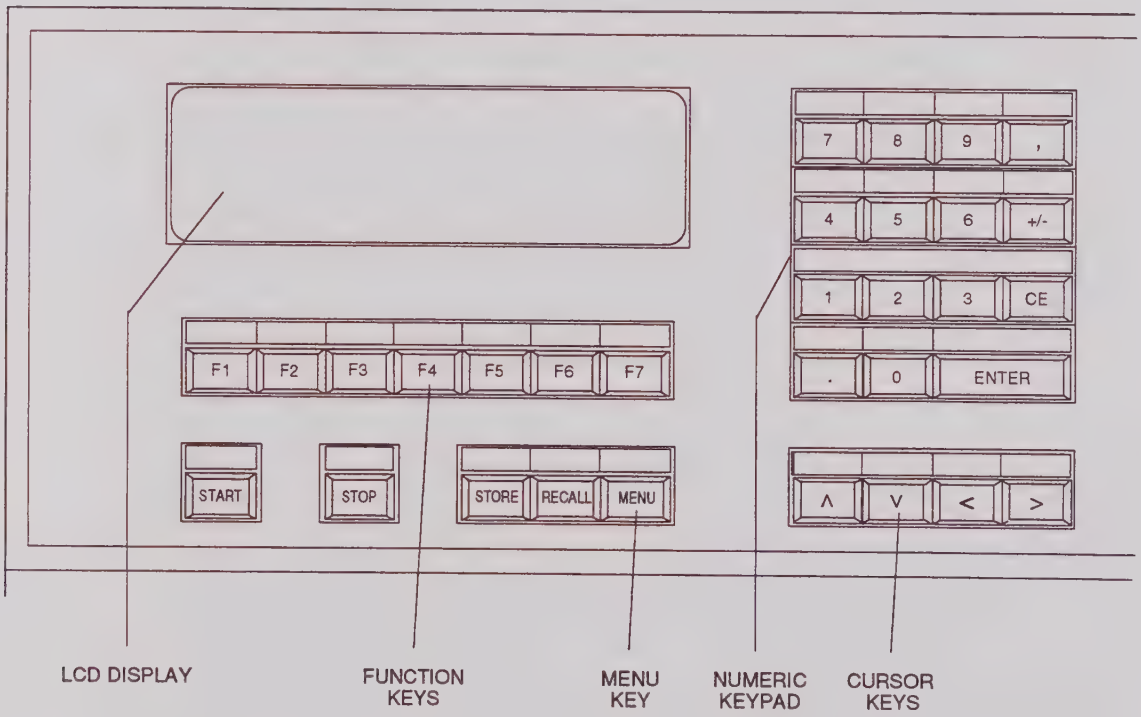

Figure 5-3. ECAT Virtual Front Panel (VFP)

Virtual Front Panel Controls

LCD Display - Displays self test results, and Test and Measurement menus. Instrument control parameters are set up by editing the contents of fields on the menus.

Menu Key - Interrupts the current display and switches back to the previously displayed menu. Also used to switch control back to the VFP main menu when the instrument is under remote control from the Microsoft Windows ECAT software.

Clear Entry (CE) Key - Clears the contents of a numeric field before entering a new value.

Enter Key - Context sensitive. For numeric fields, the *Enter* key locks in a new value after the value is keyed in from the numeric keypad. For itemized list fields, *Enter* steps through the items in the list.

Numeric Keypad - Used to enter digits into a numeric field.

Cursor Control Keys - The up and down cursor keys are used to step vertically through the fields on a menu. The left and right cursor keys are used to move horizontally through multiple fields when they appear on a single line. In a numeric field, they move the digit cursor left and right through the field.

Function Keys - Seven keys whose functions change depending on which menu is displayed. One or more of these may be inactive. Legends for the active keys are displayed at the bottom of the LCD. Do not confuse these keys with the function keys on an external computer.

Start, Stop Keys - Used to start and stop a PQF or an EFT/Burst test. Inactive for surge testing.

Store and Recall Keys - Used to store and recall PQF test sequences.

The control panel automatically tailors itself to the actual test system configuration, as determined at power up. Only those options installed in the system can be specified.

During power up, the Virtual Front Panel displays the self test screen and then the top level ECAT system menu. Menus used to set up and measure the results of a surge test are described below.

Selecting and Modifying Parameters in the VFP Menu

The currently selected field is highlighted in reverse video. The ↑ and ↓ keys move the field cursor vertically from row to row. On rows with more than one field (*e.g.*, *Waveform* and *Output at* in the surge menu), the → and ← keys move the field cursor horizontally across the row.

The values permitted for each field and the type of field entry to use are listed later in this chapter in Table 5-4. Some fields require the entry of a number, others require selection from a list of itemized options. Modify each field as follows:

For **numeric entry fields** - Press *CE* to clear the existing value. Key in the new value using the numeric keypad. Press *Enter* to lock in the new value. If *Enter* is not pressed, the previously entered value is retained.

For **itemized lists** - Press *Enter* to scroll through the list of permitted values. As each value appears, it locks in automatically until a new value is chosen. Pressing +/- allows you to reverse direction through the option list. This is helpful for backing up in a long list. The symbol > or < appears to the left of the field to indicate the direction of travel through the list.

Depending on the instrument setup, some fields may be inactive. They either appear blank or display *N/A*. An inactive field can be selected, but it cannot be modified. An attempt to alter an inactive field will sound an error beep.

Power Up Self Test Display

Upon power up, the instrument performs a self test during which the display monitors the test progress and shows the final results (Figure 5-4). As the test proceeds, the remaining time counts down on the display. Upon successful completion, the following function keys are enabled:

- F1 - Surge menu.
- F3 - EFT menu
- F7 - PQF menu

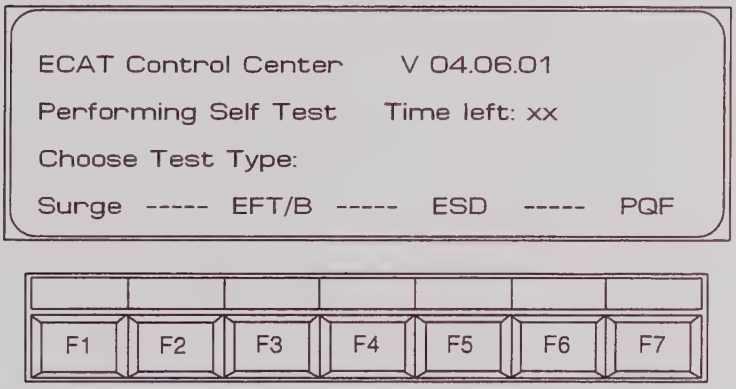

Figure 5-4. Virtual Front Panel - Power Up Self Test

Surge Testing from the Virtual Front Panel

Surge tests initiated from the front panel are primarily single-shot tests. The steps are:

- Enter surge parameters
- Enter measurement parameters
- Enable and turn on power to the EUT if using a power line coupler/decoupler
- Charge up the high voltage system
- Deliver the surge to the EUT

Surge parameters define the network, waveform, amplitude, source impedance and coupling of the surge wave. Measurement parameters define the sources of current and voltage used to measure the waveform at the load. Both sets of parameters are entered via the keypad using menus displayed on the VFP. Each set has a separate menu, described below.

EUT power is enabled from one of the menus and is then manually turned on with the blue *EUT Mains* switch on the ECAT control center. When EUT power is on, the light inside the switch turns on.

Note

EUT power does not turn on unless all of the EUT power override conditions are cleared and all interlocks are met. Only turn EUT Mains on after all enabling conditions are met. If EUT Mains is turned on when an override exists, you must turn EUT Mains off, clear the override and then turn EUT Mains back on after the override is cleared.

Charging and surging are accomplished by pressing function keys on the VFP. The high voltage will not charge up unless all interlocks are met. The loss of any interlock immediately disables and internally discharges the high voltage system.

Surge Test Menu

The Surge Test menu is shown in Figure 5-5. The screen is divided into several areas:

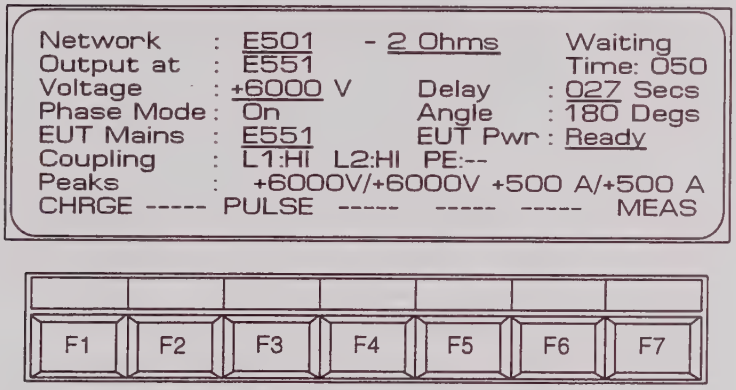
Network : E501 - 2 Ohms Waiting
Output at : E551 Time: 050
Voltage : +6000 V Delay : 027 Secs
Phase Mode : On Angle : 180 Degs
EUT Mains : E551 EUT Pwr : Ready
Coupling : L1:HI L2:HI PE:--
Peaks : +6000V/+6000V +500 A/+500 A
CHRGE ----- PULSE ----- ----- ----- MEAS
F1
F2
F3
F4
F5
F6
F7

Figure 5-5. Surge Test Menu

Status display - Located in the top right hand corner of the display, it displays one of the following five messages:

- *Idle* - Initial display when Surge Test menu is invoked. F1 begins Charging.
- *Charging* - Displays while the surge voltage is charging up. Pressing any function key cancels the operation and dissipates any high voltage accumulated.
- *Ready* - The high voltage is fully charged and ready to pulse. F3 fires the surge. After 10 seconds in this state, the high voltage charge is dumped and the instrument returns to Idle.
- *Surging* - Displays for 1 second, while the surge is delivered to the EUT.
- *Waiting* - Displays until the countdown delay timer expires (see Table 5-1). The time remaining is displayed just below the field *Delay*. During the countdown, surge test and measurement parameters may be modified, but a new charge cycle cannot be started until the timer expires and the status display returns to Idle.

Function key labels - Located on the bottom line. These legends align with function keys F1 through F7 located below the display. Function key legends are context sensitive and may change as the instrument status changes. Pressing an inactive function key has no effect.

Peaks detector display - Located on the next-to-bottom line. Shows the peak voltage and current measured during the *last* surge test at the terminals *V Mon* and *I Mon* on the instrument control center. Both the positive and negative peaks are captured and displayed. When the instrument is first turned on, these values are zero. They are reset to zero at the start of a charge cycle. This section only appears when voltage and current monitor options are installed in the system.

Setup parameters - Eight fields are used to set up a test, shown underlined in Figure 5-6 and listed in Table 5-1. The underlines in the figure are for identification purposes only; they do not actually appear on the instrument screen.

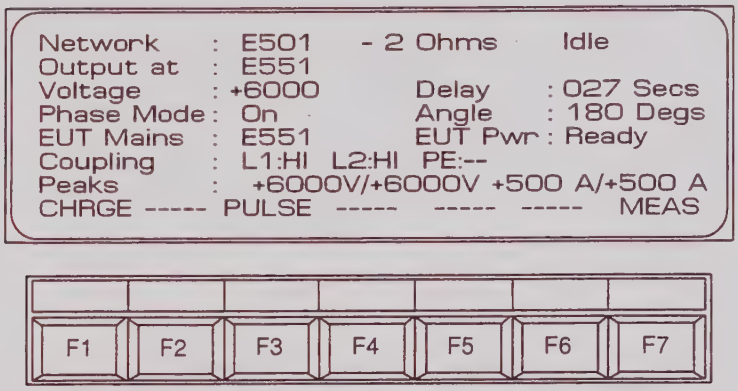

Figure 5-6. Sample Surge Test Menu

Table 5-1. Surge Test Menu, Fields and Allowed Values

Field Name	Description	Allowed Values	Type
Network (1st field)	Choose the surge network source.	Restricted to model numbers of surge networks installed in system.	Itemized list
Network (2nd field)	Choose the waveform characteristics and output impedance as provided by selected network.	Choices vary according to the surge network specified. Options are listed in Table 5-2.	Itemized list
Output at	Choose a coupler/decoupler or specify output at the surge network banana jacks.	Choices restricted to those coupler/decouplers installed, or the surge module specified in *Network* (1st field).	Itemized list
Voltage	Peak open circuit voltage level for the surge waveform source.	Zero to the maximum voltage allowed for the selected surge network and waveform	Numeric entry
Phase Mode	Defines whether surge is synchronized to a specific phase angle of a selected AC line.	RNDM (random, i.e. not synced), L1, L2, L3[a]. If *Output at* specifies the surge network, this field displays *N/A* and may not be altered.	Itemized list
Phase Angle	Phase of the AC power line when surge is applied. Phase is referenced to the line specified in *Phase Mode*.	0 to 360 degrees in 1 degree increments. If *Output at* specifies the surge network, or if *Phase Mode* is *RNDM*, this field displays *N/A* and may not be altered.	Numeric entry
EUT Mains	Specifies the coupler/decoupler to deliver EUT power when EUT Power is ready and turned on.[b]	Choices restricted to those coupler/decouplers installed.	Itemized list
EUT Pwr	Enables or disables the *EUT Mains* switch.[c]	Choices are *Ready* and *Off*.	Itemized list
Coupling	Specifies how the surge is coupled to the EUT. Designates the power lines (including Neutral and PE) to which the surge will be connected.	Choices vary according to the surge network specified and whether a coupler/decoupler is specified for *Output at*. See Table 5-3. If *Output at* specifies the surge network, this field displays *N/A* and may not be altered.	Itemized list
Delay[d]	Minimum delay between surges.	0 to 999 seconds in 1 second increments.	Numeric

[a] L2 and L3 appear only for three phase couplers

[b] Allows powering an EUT from a coupler/decoupler even when EFT/Burst is not applied via the power line.

[c] Setting *EUT Power* to *Ready* does not actually energize the EUT. That must be done manually using the blue *EUT Mains* switch located on the instrument control center. However, setting this option to *Off* does turn off power to the EUT, even if *EUT Mains* is latched in the on position. You must reset *EUT Mains* switch off *before* re-enabling EUT Power from the menu.

[d] *Delay* defines the minimum time after the start of one charge cycle until another charge cycle can begin. The default value is the minimum time allowed in hardware, which depends on duty cycle and thermal limits of the surge network and differs for each network. The actual delay time entered should take into consideration surge to surge time defined for the specified test and should not exceed specified design limits for the EUT.

Table 5-2. VFP Surge Test Menu, Selections for *Network* (2nd field)

Network (1st Field)	Network (2nd Field)	Waveform Characteristics
E501	2 OHMS 12 OHMS	1.2/50 µs OCV, 8/20 µs SCI Combination Wave 0-6 kV, 3 kA 2 Ω 1.2/50 µs OCV, 8/20 µs SCI Combination Wave 0-6 kV, 500 A 12 Ω
E502 E502H	10/700 µS .5/700 µS	10/700 µs OCV Waveform 0-6 kV (0-7 kV for E502H) 0.5/700 µs OCV Waveform 0-6 kV (0-7 kV for E502H)
SWE502 SWE502H	10/700 µS .5/700 µS 100/700 µS	10/700 µs OCV Waveform 0-6 kV (0-7 kV for SWE502H) 0.5/700 µs OCV Waveform 0-6 kV (0-7 kV for SWE502H) 100/700 µs OCV Waveform 0-5 kV (0-6 kV for SWE502H)
E503	100 KHZ 200A 100 KHZ 500A	100 kHz Ring Wave 0-6 kV, 200 A 100 kHz Ring Wave 0-6 kV, 500 A
E504	1.2/50 500A 1.2/50 750A	1.2/50 µs OCV, 8/20 µs SCI Combination Wave 0-6 kV, 500 A 1.2/50 µs OCV, 8/20 µs SCI Combination Wave 0-6 kV, 750 A
E505	800 V 100A 800 V 200A 1.5 KV 200A 2.5 KV 1KA	<$\overline{10}$ x > 560 µs 0-800 V, 100 A <$\overline{10}$ x > 560 µs 0-800 V, 200 A <$\overline{10}$ x > 160 µs 0-1.5 kV, 200 A <$\overline{2}$ x > 10 µs 0-2.5 kV, 1000 A
E506[a]	800 V 100A 1.5 KV 100A 2.5 KV 500A 5.0 KV 500A	<2 x > 10 µs SCI 0-800 V, 100 A per side <2 x > 10 µs SCI 0-1.5 kV, 100 A per side <2 x > 10 µs SCI 0-2.5 kV, 500 A per side <2 x > 10 µs SCI 0-5.0 kV, 500 A per side
E510	2 OHMS 12 OHMS	1.2/50 µs OCV, 8/20 µs SCI Combination Wave 0-10 kV, 5 kA 2 Ω 1.2/50 µs OCV, 8/20 µs SCI Combination Wave 0-10 kV, 833 A 12 Ω
E511	1.2/50 µS	1.2/50 µs OCV, 8/20 µs SCI Combination Wave 0-6 kV,5 kA 1.2 Ω

[a] Not intended for power line coupling.

Table 5-3. Surge Coupling Options for Coupler/Decouplers

Coupler/ Decoupler	Coupling Options	
	Surge Lo	**Surge Hi**
E551, E552 single phase	PE	L1[a] and L2[b] L1 L2
	L1	L2
	L2	L1
E553, E554 three phase[c]	PE	Any of N, L1, L2 and L3 taken singly, or in any combination of 2, 3 or all choices
	N	Any of L1, L2 and L3 taken singly or paired in any way, or all three combined
	L1	Any of N, L2 and L3 taken singly or paired in any way, or all three combined
	L2	Any of N, L1 and L3 taken singly or paired in any way, or all three combined
	L3	Any of N, L1 and L2 taken singly or paired in any way, or all three combined

[a] The coupling impedances into each conductor are identical. Actual surge currents are dependent on the load impedance of each line.
[b] In 120 volt circuits in the USA, L2 is equivalent to Neutral.
[c] 5-wire Y circuits.

Surge Measurement Menu

The surge measurement menu of Figure 5-7 controls the sources of voltage and current to the measurement monitor connectors, *V Mon* and *I Mon*. The four fields shown in Figure 5-7 and described in Table 5-4 are used to configure the measurement monitors. (They are shown underlined in the figure for identification purposes, but the underlines do not actually appear on the instrument screen.)

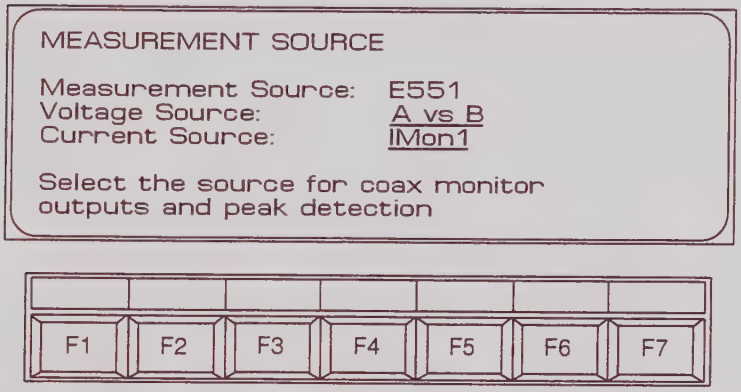

Figure 5-7. Surge Measurement Menu

Table 5-4. Measurement Menu, Choices for the Field Measurement Source

Type of Source	Source Module	Choices[a b c]
Voltage	E501, E503, E504, E505 E510 and E511	A vs. B[b]
	E502, E506	A vs. B[b] A vs. C[b] B vs. C[b]
	E551, E552	A vs. B A vs. C[c] B vs. C[c]
	E553, E554	A vs B A vs C B vs C
Current	E501, E503, E504, E505 E510 and E511	IMON1[b]
	E502, E506	IMON1 (OUT HIGH 0 Ω[b]) IMON2 (OUT 1 HIGH 25 Ω[b]) IMON3 (OUT 2 HIGH 25 Ω[b])
	E551, E552	IMON1 (L1) IMON2 (L2) IMON3 (PE[c])
	E553, E554	IMON1 (L1) IMON2 (L2) IMON3 (L3)

[a.] The meanings of voltage monitor inputs A, B, C are assigned in accordance with the measurement point jumpered to the connectors on the module.
[b.] Surge networks in the standard configuration do not have voltage or current monitoring capability. These choices only appear in the menu if the VI measurement option is installed in the selected surge network.
[c.] Coupler/decouplers in the standard configuration have two voltage monitor connectors and two current sources. These choices only appear in the menu if the Total VI measurement option is installed in the selected coupler/decoupler.

EFT/Burst testing from the Virtual Front Panel

Tests initiated from the front panel are single-shot and continuous. The steps are:

- Enter test parameters
- Enable and turn on power to the EUT
- Start the test using the *Start* key

Setup parameters define the nature and coupling of the EFT/Burst pulse train. They are set up with the keypad using menus displayed on the VFP as described below.

EUT power is enabled from one of the menus and is then manually turned on using the blue *EUT Mains* switch on the ECAT control center. When EUT power is on, the light inside the switch turns on.

Note

EUT power does not turn on unless all of the EUT power override conditions are cleared and all interlocks are met. Only turn EUT Mains on after all enabling conditions are met. If EUT Mains is turned on when an override exists, you must turn EUT Mains off, clear the override and then turn EUT Mains back on after the override is cleared.

The EFT/Burst high voltage will not turn on unless all interlocks are met. The loss of any interlock immediately turns off the high voltage system.

EFT/Burst Test Menu

The Test Menu is shown in Figure 5-8.

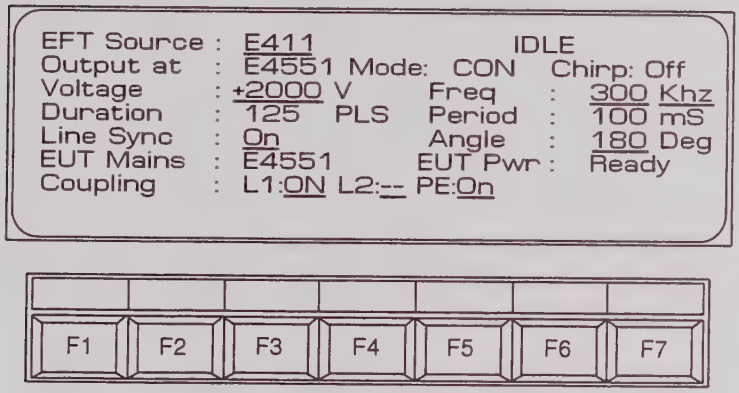
EFT Source : E411 IDLE
Output at : E4551 Mode: CON Chirp: Off
Voltage : +2000 V Freq : 300 Khz
Duration : 125 PLS Period : 100 mS
Line Sync : On Angle : 180 Deg
EUT Mains : E4551 EUT Pwr : Ready
Coupling : L1:ON L2:-- PE:On
F1
F2
F3
F4
F5
F6
F7

Figure 5-8. EFT/Burst Test Menu

The screen is divided into several areas:

Status display - Located in the top right hand corner of the display, it shows one of the following five messages:

- *Idle* - Initial display when EFT/Burst Test menu is invoked.
- *Computing* - Displays while the ECAT microprocessor is busy preparing for a test.
- *Charging* - Displays while the EFT/Burst voltage is charging up. Pressing any function key cancels the operation and dissipates any high voltage accumulated.
- *Running* - Displays while EFT/Burst test is being delivered to the EUT.

Setup parameters - Thirteen fields used to set up a test, shown underlined in Figure 5-8 and listed in Table 5-5. (The underlines in the figure are for identification purposes only; they do not actually appear on the instrument screen.)

Table 5-5. EFT/Burst Menu, Fields and Allowed Values

Field	Description	Allowed Values	Type
EFT Source	Specifies the EFT/Burst source	Choices restricted to the installed EFT/Burst sources installed.	Itemized list
Output at	Choose a coupler/decoupler or specify EFT OUT 1 connector	Choices restricted to *EFT OUT 1* and those coupler/decouplers installed.	Itemized list
Voltage	Peak voltage level for individual pulses in the EFT/Burst output.	Zero to the maximum voltage allowed for the selected network; rounded to nearest 5 V.	Numeric entry
Duration/ Units	Duration of the pulse burst and units, in cycles or milliseconds	Duration: 0-999 Units: PLS (pulses) or ms	Numeric list
Phase Mode	Defines whether surge is synchronized to a specific phase angle of a selected AC line.	RNDM (random, i.e. not synced), L1, L2,[a] or L3. If *Output at* specifies the surge network, this field displays *N/A* and may not be altered.	Itemized list
EUT Mains	Specifies the coupler/decoupler to deliver EUT power when EUT Power is ready and turned on.[b]	Choices restricted to coupler/decouplers installed.	Itemized list
Coupling	Specifies how surge is coupled to the EUT. Designates the power lines (including Neutral and PE) to which the surge will be connected.	Choices vary according to the surge network specified and whether a coupler/decoupler is specified for *Output at*. See choices in Table 5-6. If *Output at* is *Out1*, this field displays *N/A* and may not be altered.	Itemized list
Mode	Defines whether output is a single burst or a train of bursts	*MOM* (momentary) or *CON* (continuous)	Itemized list
Chirp	Defines whether Chirp is enabled.[c]	On or Off	list
Frequency / Units	Defines the pulse-to-pulse frequency in a burst.	1 - 9999 Hz or 1 - 1000[d] kHz. If *Chirp* is on, *Frequency* is *N/A* and may not be altered.	Numeric entry
Period	Defines the burst-to-burst spacing in a pulse train	300 - 500 ms	Numeric entry
Angle	Phase of the AC power line when the first pulse of a burst is applied. Referenced to Line Specified in *Phase Mode*.	0 to 360 degrees in 1 degree increments. If *Output at* is *Out1*, or if *Phase mode* is off, this field displays *N/A* and may not be altered.	Numeric entry
EUT Power	Enables or disables the *EUT Mains* switch.[e]	*Ready* or *Off*.	Itemized list

[a] L2 and L3 appear only for three phase couplers.
[b] Used to allow powering an EUT from a coupler/decoupler even when EFT/Burst is not applied via the power line.
[c] When Chirp is on, the spacing between pulses within a burst changes with each pulse.
[d] 1- 2000 kHz, optional.
[e] Setting EUT Power to *Ready* does not actually energize the EUT. That must be done manually using the blue *EUT Mains* switch located on the instrument control center. However, setting this option to *Off* does turn off power to the EUT, even if *EUT Mains* is latched in the on position. You must reset *EUT Mains* switch off before re-enabling EUT Power from the menu.

Table 5-6. Coupling Options for EFT/Burst Coupler/Decouplers

Coupler/ Decoupler	EFT/Burst Coupling Options
Single Phase E412, E422 (internal) E4551, E4552 (external, combined Surge and EFT/Burst)	Any of PE, L1 and L2[a] taken singly or paired[b] in any way, or all three combined.
Three Phase[c] E4553, E4554 (external, combined Surge and EFT/Burst)	Any of PE, N, L1,L2, and L3 taken singly or in any two-, three- or four-way combination, or all five lines combined.

[a] In 120 Volt circuits in the USA, L2 is equivalent to Neutral.
[b] The coupling impedances into all conductors are identical. Actual pulse shape depends on the load impedance of each line.
[c] 5-wire Y circuits.

PQF testing from the Virtual Front Panel

PQF test sequences are initiated from the front panel by:

- Defining PQF parameters for each step
- Enabling and turning on power to the EUT
- Starting the Test using the *Start* key

A test ends either because it finishes all of its steps, because a current limit is exceeded, or in the case of an infinitely looping test, by the pressing of the *Stop* key on the VFP.

Setup parameters define the nature and coupling for each step in a PQF test. Parameters are entered with the keypad using menus displayed on the VFP.

Once a test sequence is defined, it may be stored in non-volatile memory using the *Store* key. When the PQF menu is active, pressing the *Recall* key overwrites the presently defined sequence with the test sequence last saved.

EUT power is enabled from one of the menus and is then manually turned on by the *EUT Mains* push button on the ECAT control center. When EUT power is on, the push button is illuminated.

Note

EUT power does not turn on unless all of the EUT power override conditions are cleared and all interlocks are met. Only turn EUT Mains on after all enabling conditions are met. If EUT Mains is turned on when an override exists, you must turn EUT Mains off, clear the override and then turn EUT Mains back on after the override is cleared.

The PQF source does not turn on output power unless all interlocks are met. The loss of any interlock immediately turns off the EUT power

PQF Menu

The PQF menu is shown in Figure 5-9.

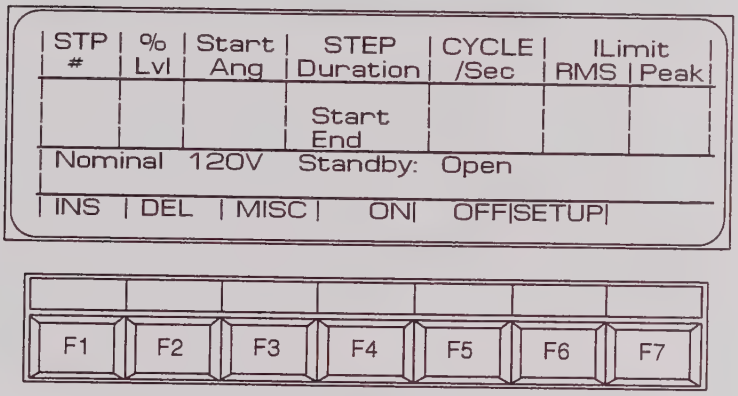

Figure 5-9. PQF Menu

The screen is divided into several areas:

Test List Headings - The list headings identify the six parameters defined for each step in the sequence. Parameters are described in Table 5-7.

Test List - Displays individual steps in the sequence, along with *Start* and *End* of the list markers. The up and down cursor keys on the ECAT front panel move the cursor up and down through the list. The left and right cursor keys function as follows:

- *Right cursor* - (Field cursor) Moves the reverse-video cursor to the right-most character position in the next field to the right. Wraps around from the last field on the right to the first field on the left.
- *Left cursor* - (Character cursor) Moves the reverse-video cursor one character position to the left. Steps from the first character position of one field to the last position of the field to the left. Wraps around from the first character position of the left-most field to the last character position of the right-most field.

Nominal/Standby Settings - Displays the current setting for *nominal* input voltage level and the *standby* setting.

The *standby* setting can be changed by pressing F6 to display the *Setup* menu, pressing F1 or F2 for the desired value, and then pressing F6 (*Done*) to return to the test menu.

The *Idle* setting specifies the power applied to an EUT when *the EUT Power* switch on the ECAT system is turned on and the PQF generator is **not** running a test sequence. The allowed values are either *100%* (power on) or *Open* (power off).

Function keys - Located on the bottom line. These legends align with function keys F1 through F7 located below the display. Function key legends are context sensitive and may change as the instrument status changes. Pressing an inactive function key has no effect.The following keys are active on the PQF menu:

- *Ins* - Inserts a new test step into the list after the currently selected step. After the step is added, it may be modified at will.
- *Del* - Deletes the currently selected step.
- *Misc* - Inserts a *GoTo 1* (one) statement after the currently selected step. This causes the test to loop back to the first step in the list. After a *GoTo* command is inserted in the list, its target may be changed from *1* (one) to any existing step number.
- *On* - Enables EUT power. EUT power does not actually turn on until all interlocks are met and the blue EUT Mains switch at the top right of the ECAT system is turned on.
- *Off* - Disables EUT power.[3]
- *Setup* - Displays a setup menu which allows adjusting display contrast and defining values for *Idle* and *Nominal*.

[3]. This is different from the function of the *Stop* switch which halts the active test but leaves EUT power at the level defined by *Standby*.

Table 5-7. PQF Test Menu, Fields and Allowed Values

Field Name	Description	Allowed Values
% Lvl	Specifies the voltage level for the highlighted step	0% - Open, 0% - Short, 40%, 50%, 70%, 80%, 90%, 100%, 110%, 120%, 150%
Start Ang	Specifies the starting phase angle[a] for the highlighted step.	0 - 360 degrees
Step Duration	Specifies the duration for the highlighted step.	0 - 99999 For step shorter than 1 cycle, enter 0.
Cycles / Sec	Specifies whether the step duration is expressed in cycles or in seconds.	*Cycle* or *Sec*
I Limit RMS	Defines the maximum allowable RMS current to the EUT. If this limit is exceeded, the test sequence in progress halts and EUT power shuts down.	1 - 32 Amps Enter 0 to disable RMS current limit checking.
I Limit Peak	Defines the maximum allowable peak current to the EUT. If this limit is exceeded, the test sequence in progress halts and EUT power shuts down.	1 - 100 Amps Enter 0 to disable Peak current limit checking.

[a] If there is a slight gap during a test sequence between the end of one step and the start of a new one, the previous step is extended slightly until the new step begins. This can happen, for example, when a step starting at phase angle of 0 degrees with a duration stated in cycles is followed by a step starting at a phase angle of 90 degrees.

Understanding SurgeWare

The SurgeWare window is similar to that shown in Figure 5-10. As various options are selected, parts of the display change and may differ from what is shown.

The SurgeWare window contains several controls such as sliders, push buttons and list boxes. These are standard Microsoft Windows graphical objects, familiar to Microsoft Windows users. Even if you are new to Windows, you will find that the controls operate intuitively after just a few moments of experimentation.

The controls are clustered in groups that affect operation of SurgeWare or define the parameters for a surge test. These groups include:

Menu Bar - Pull down menu provides access to on-line help, software and firmware version numbers, and allows saving, retrieving and renaming test files on disk.

Order Group - For test sequences that vary by more than one surge parameter, this group defines the order in which the tests and repetitions are run. In the group there is an icon for each group of parameters that can vary. As test sequences are built, SurgeWare arranges these icons into a flow chart. You can modify the order of tests by dragging icons with the mouse so as to rearrange the flowchart.

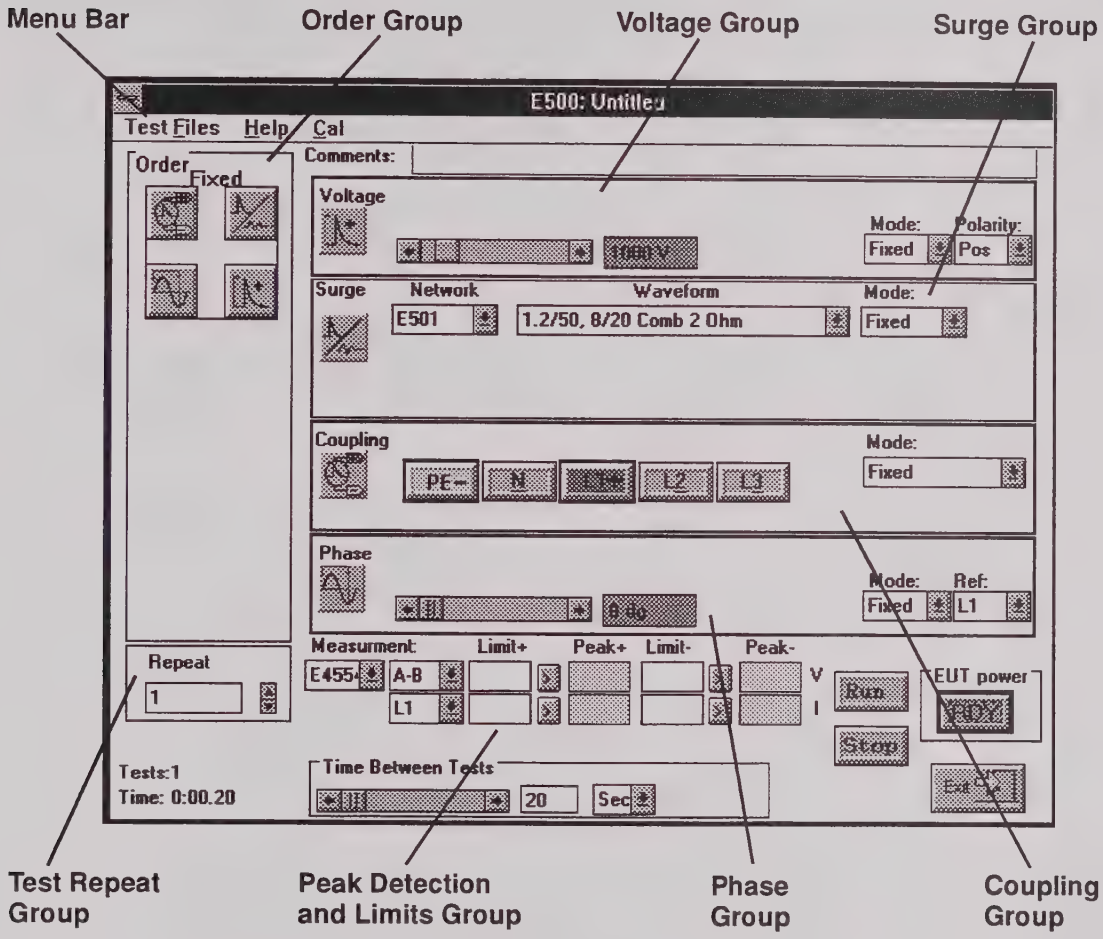

Figure 5-10. SurgeWare Display

Voltage Group - Defines the voltage and polarity of individual surge tests and sequences of tests. In a test sequence, voltage may be stepped through a linear or logarithmic range or through a list of preset values.

Table 5-8 lists the controls unique to the *Voltage* group. The *Mode* control and the *N Steps/Step Size* controls, all of which are used in other groups, are described separately in Table 5-12 and the text following that table.

Table 5-8. Voltage Group Controls

Control Name	Description	Values
Voltage icon	Passive, identifies which icon in the Order group symbolizes *Voltage*.	N/A
Voltage slider	Selects output pulse voltage level.	Varies according to the type of network
Start slider Stop slider	Identifies the starting voltage and the upper limit test sequences that vary surge voltage in linear or logarithmic increments. These controls are only present when *Mode* is *Linear* or *Log*.	Min and max values for each slider vary according to the type of network
List box Insert button Delete button	List box contains an entry for each set of voltage group parameters specified as a test step. The *Insert* button adds the presently specified surge voltage and polarity to the end of the list. The *Delete* button removes the highlighted entry; if no entry is highlighted, it removes the last entry.	N/A
Step Size, N Steps, and step toggle buttons	*N Steps* defines how many additional[a] tests to run spanning the specified voltage range. *Step Size* defines how much the voltage is to increment per test, until it exceeds the *Stop* level. The two options are mutually exclusive. When *Mode* is Log, only *N Steps* is available. When *Mode* is *Linear*, the step toggle button (marked with an >) is used to change between the two options. Shown only when *Mode* is either *Log* or *Linear*.	N/A
Mode	Defines whether a single value or a range of values is to be used for the *Voltage*.	See Table 5-12
Polarity	Defines whether surge polarity is to remain fixed (*Pos* or *Neg*) during a test sequence, or whether it is to alternate for every test or every five tests.	Pos, Neg, Alternate 1 each, Alternate 5 each

[a] For *N Steps* equal to four, a total of five tests will run.

Surge Group - Defines the surge source, the type of wave and other options for a single test or a sequence of tests. Sequences may consist of a list of preset steps that vary any of these values. There are no range options for this group.

Table 5-9 lists the controls unique to the *Surge* group. The *Mode* control, used in other groups, is described separately in Table 5-12.

Table 5-9. Surge Group Controls

Control Name	Description	Values
Surge icon	Passive, identifies which icon in the Order group symbolizes *Surge*.	N/A
Network	Selects which surge network is the source.	Select among model numbers of all installed networks
Wave	Selects which waveform to use.	Varies according to the selected network
Options	Optional characteristics (e.g. output resistance).	Varies according to the selected network
List box Insert button Delete button	Controls similar to those described in Table 5-4. Allows changing network, waveform and options for each test in a sequence.	N/A
Mode	Defines whether a single network, waveform or Options is to be used for the *Surge* parameters or whether one or more will vary during a test sequence.	See Table 5-12

Coupling Group - Defines the surge coupling. Use it to specify whether the surge is coupled directly to the output of the surge network or through specified power lines using the coupler/decoupler. When output is through the coupler/decoupler, you specify the lines to which the surge is coupled either for a single test or for a sequence of tests.

The group provides two shortcut buttons for instantly defining often-used test lists. One creates a list that includes all coupling possibilities, the other creates a smaller list of standard couplings appropriate to the coupler/decoupler in use. This is especially helpful for three-phase couplers where there are a dozen standard tests and over sixty possible combinations.

Table 5-10 lists the controls unique to the *Coupling* group. Most of the controls described do not appear if *Coupling Mode* is set to *Surge Network*. The *Mode* control, used in other groups, is described in Table 5-12.

Table 5-10. Coupling Group Controls

Control Name	Description	Values
Coupling icon	Passive, identifies which icon in the Order group symbolizes *Coupling*.	N/A
Invalid Mode indicator	Displays when specified coupling is invalid, missing or incomplete (i.e., when only surge Hi or Low is specified).	N/A
Coupling buttons	Specifies which surge output, if any, is coupled to each power line. The symbol + appears when a line is connected to surge Hi, the symbol – appears when the line is connected to surge Lo. Each time the button for a line is clicked, it changes to the next available option.	Hi (+) Lo (–) or none (blank)
List box Insert button Delete button	Controls operate similarly to those described in Table 5-5. Allows coupling for each test in a sequence.	N/A
Mode	Defines whether a single value or a range of values is to be used for the Coupling parameter.	See Table 5-12

Phase Group - Defines the phase angle of the AC power cycle at which the surge fires. This group is used to set up a single test or a sequence of tests. The sequence can consist of a list of preset phase values or span a range of values over which the phase is varied in linear or logarithmic steps.

The entire group is removed from the screen when *Coupling Mode* is set to a surge network instead of a coupler/decoupler.

Table 5-11 lists the controls unique to the *Phase* group. The *Mode* control plus the *N Steps* and *Step Size* controls, which are used in other groups, are described in Table 5-12 and the text following that table.

Table 5-11. Phase Group Controls

Control Name	Description	Values
Phase icon	Passive, identifies which icon in the Order group symbolizes Phase.	N/A
Phase slider	Defines the phase angle at which the surge fires. Phase is defined relative to line L1 of the EUT Mains supply.	0-360 degrees
Start slider Stop slider	Defines the starting phase and the upper phase limit in test sequences that vary the phase parameter.	0-360 degrees
List box Insert button Delete button	Controls similar to those described in Table 5-5.	N/A
Step Size, N Steps	Controls similar to those described in Table 5-5.	N/A
Mode	Defines whether a single value or a range of values is to be used for the phase parameter.	See Table 5-12

Peak Detection/Limits group - A series of controls that define how peak detection is to be performed and optionally allow suspending the test sequence upon detecting a specified condition. The entire group is removed from the screen when *Coupling Mode* is set to a surge network instead of the coupler/decoupler. The group includes the following controls:

- *Measurement* - Two list boxes which define the source for the voltage and current peak detectors. The top list box defines the voltage measurement type; presently, only the differential A-B measurement is defined. The lower list box defines which current transformer is used for the current peak detection. *Auto* specifies that the phase being surged is to be used for peak detection.
- *Peak+ and Peak– (minus)* - Four boxes, show the peak positive and negative voltage and current value measured by the peak detectors during the last surge.
- *Limit+ and Limit– (minus)* - Four edit boxes and four condition selectors that allow suspending a test sequence if the peak detectors detect a specified condition. One or more of these values may be left blank to disable limit detection at the corresponding peak detector.

  For example, to specify that the test sequence should be interrupted if the positive-going peak surge current exceeds 1000 amps: Enter 1000 in the lower box under *Peak+* and click on the adjacent selector button until the legend shows >. Then make sure the remaining three Limit boxes are blank.

Miscellaneous indicators and controls - There are various other indicators and controls located in the SurgeWare window, including:

- *Comments* - A text field located near the top of the screen in which you may save comments about the current test sequence.
- *Run, Stop and Step buttons* - Push buttons, located lower right, that start a test, stop it, or manually step the simulator through a test sequence.
- *EUT Power button* - Push button, located lower right, that enables or disables the EUT power system. When the button legend is *Off*, the EUT power system is disabled, when the legend is *READY*, the system is enabled. The push button does not actually control EUT power. For safety reasons, power must be manually turned on using the switch *EUT Mains*, located on the ECAT control center.
- *Exit button* - Located lower right, shuts down SurgeWare and returns control to Microsoft Windows.
- *Tests* - Displays the total number of tests defined in the current sequence. While a sequence is running, this indicator displays the number of the step currently running. Located lower left of screen.
- *Time* - Displays, in 24 hour format, the total time for the current test sequence to run from start to finish. This value is the product of the number of tests times the time between tests. Located lower left of screen.
- *Test Repeat Group* - Defines how many times the specified test or a test sequence is to run. Range is 1 - 9999, default is 1.
- *Time Between Tests* - This group of controls defines the time between tests in a test sequence. Minimum time is twenty seconds; maximum time is 99 hours. This is a global setting that remains in effect for all tests in a sequence. However, the time between tests may be changed on-the-fly during a test sequence by pausing the sequence, changing the time, and then resuming the run.
- *Status* - At the right side of the *Time Between Tests* group, a status indicator shows whether the ECAT system is idle. While a test is running, a countdown timer appears within the group showing the time remaining until the next surge fires.

Mode control - A special list box that appears within four of the control groups; *Voltage, Surge, Coupling* and *Phase*. The mode function allows the setup of various kinds of test sequences. As each mode is invoked, the configuration of controls inside the group changes, providing access to the functions that are unique to that mode. The Mode Controls are listed and described in Table 5-12. Additional information about the controls *Step Size* and *N Steps* follows the table.

Table 5-12. Mode Controls in SurgeWare

Option Name	Description	Present in Group			
		Voltage	Surge	Coupling	Phase
Fixed	Specifies the control group mode is *fixed*. The parameters set up in the control group remain constant - either for single test, or while parameters in other control groups are allowed to vary in a test sequence.	■	■	■	■
List	Specifies the control group mode is *list*. Adds a *List* display plus *Insert* and *Delete* buttons to the group. Build a test sequence by adding individual tests one at a time using *Insert*. A list is persistent; it remains in existence until it is explicitly cleared with *Delete* or with *NewList* which clears the entire list. However, when the list is not visible on the screen (i.e., when mode is *Linear*, *Log* or *Fixed*) the list becomes inactive and is ignored during a test run.	■	■	■	■
Linear	Specifies the control group mode is *linear*. Adds *Start* and *Stop* limits which define the range of values to span. Adds *N Step* and *Step Size* buttons (see accompanying description). For each step in the test sequence, the value of the variable parameter increases in linear steps until the stop limit is reached.	■	■		■
Log	Specifies the control group mode is *logarithmic*. Adds *Start* and *Stop* limits which define the range of values to span. Also adds the *N Step* box (see accompanying description). For each step in the test sequence, the value of the variable parameter increases in logarithmic steps until the stop limit is reached.	■	■		■
New List	Clears the list if one exists, sets mode to *List*.	■	■	■	■
Surge Network, Standard, All	Special modes used by the *Coupling* group. *Surge Network* specifies the surge is coupled through the direct output terminals of the selected surge network, not through a power line coupler/decoupler. *Standard* and *All* insert pre-defined coupling sequences.			■	

N Steps controls - (*Log* and *Linear* modes only) - An edit box displaying how many additional test steps beyond the start value span the test range defined by the *Start* and *Stop* controls. For example, if *N Steps* is four, a total of five tests will run.

Step Size controls (*Linear* mode only) - A group of two controls - a button and an edit box- that defines how much a value increments as it steps through a linear range of values. A toggle button, marked with the angle bracket, >, controls the meaning of the value in the edit box. Clicking the button changes the box between *Step Size* and *N Steps*.

When the edit box is labeled *Step size*, the value in the box shows how many units are added to the *Voltage* or *Phase* parameter for each new test in the sequence. The total number of steps is calculated accordingly. For example, if the *Voltage* is set to span the linear range 5000 V to 6000 V with a step size of 100, eleven tests will run.

When the edit box is labeled *N Steps*, its meaning is as described above for *Log* mode.

Surge Testing from SurgeWare

Single-shot surge tests are initiated from SurgeWare as follows:

- Enter surge parameters
- Enter measurement parameters
- Enable and turn on power to the EUT
- Click on *Run* to start the test

Test sequences are defined and run similarly. The only difference between single-shot and sequence is that instead of defining a single set of surge parameters, you define several sets of surge parameters in one or more of the control groups.

Surge parameters define the nature and coupling of the surge wave. For each surge parameter, SurgeWare displays all the allowable values based on which instrument modules and options are installed in the ECAT system.

Measurement parameters define the sources of current and voltage for measuring the waveform at the load.

EUT power is enabled from the *EUT Power* group and is then manually turned on by a push button on the ECAT control center.

Note
EUT power is not on unless all of the EUT power override conditions are cleared and all interlocks are met. When EUT power is on, the blue indicator inside the switch turns on.

Charging and surging are initiated by clicking *Run* in SurgeWare. However, the high voltage will not charge up unless all interlocks are met. The loss of any interlock immediately disables and internally discharges the high voltage system.

Example: Building a Test Sequence

The following procedure illustrates the building of a surge test sequence that repeats four times. The example builds a sequence of nine tests in which two parameters are varied. In this sequence:

1. *Voltage* is varied in three steps using a test list.
2. *Phase* is varied in three linear steps through a test range.
3. Repeat tests is set to four.
4. Icons in the *Order* group are used to modify the default order of tests.

In a test sequence, the variations run cumulatively, not additively. That is, for each parameter value in one surge test, all parameter values of the sequences in all other groups are run. For that reason, in this example with three tests in one group and three tests in another, the total number of tests is nine rather than six.

The sequence assumes that the ECAT system includes the Model E501 Surge Network, and the Model E551 power line coupler/decoupler.

Initial Setup

In all of the following procedures the term *keyboard* refers to the computer keyboard, not the ECAT system keypad.

1. Turn on the ECAT system.
   If the system is already running, momentarily power it down and restart it to ensure that all conditions match the descriptions that follow.
2. Start SurgeWare on the computer.
   If SurgeWare is already running, exit the program and restart it so the value of various displays will track with the following descriptions.
3. Locate the two indicators *Tests* and *Time* in the lower left corner of the SurgeWare window. They read *Tests: 1* and *Time: 00:00.20*. As tests are added to the sequence, these values change.

Defining the Test List for Voltage

This procedure defines a test list with the following surge voltages: 300, 4000 and 6000.

1. Locate the *Surge* group control marked *Network*.
2. If the list box does not display E501:
   Single click on the arrow at the right of the listbox to pull it down and display all the available options. Then single click E501. The list box shrinks to its normal size with E501 displayed.

Note
In the steps below, the sequence of mouse clicks is omitted, and is replaced with the phrase 'select the option'.

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3. Locate the *Voltage* group control marked *Mode*.
4. Single click on the ⇓ at the right of the control and single click on the option *New List*.
   The group changes appearance; Insert and Delete buttons are added as well as an empty test list.

5. Locate the voltage slider and display inside the *Voltage* group.
6. Set the value of the slider to 300 V.
7. Click the *Insert* button located within the *Voltage* group. The 300 V surge is added to the test list. The indicators *Tests* and *Time* remain unchanged because there is still only one test defined.
8. Double click on the number 300 inside the voltage edit box. The contents of the box are highlighted.
9. Type in the value 4000. The value 4000 V appears in the box.
10. Click the *Insert* again. This adds the 4000 Volt surge to the test list.

    Tests changes to 2; *Time* changes to 00:00.40.
11. Position the mouse cursor over the *Voltage* edit box again. Notice the cursor changes from an arrow to the I-Beam. Position the cursor to the left of the 4 in 4000, and single click. Press *Delete* on the keyboard and then type in the digit 6. The edit box displays 6000 V.
12. Click *Insert* again. This adds the 6000 Volt surge to the test list.

    Tests changes to 3; *Time* changes to 00:01.00.

This completes the setup of a three-test sequence that varies the voltage.

Defining the Test Range for Phase

This procedure defines a test range of 90 degrees to 270 degrees in three linear steps, resulting in tests at 90 degrees, 180 degrees and 270 degrees.

1. Locate the EUT Power control at the lower right corner of the SurgeWare window.
2. Click the button marked *off*; it changes to *Ready*.
3. Locate *Mode* control within the *Coupling* group.
4. Select the option *Fixed*. The SurgeWare window changes slightly, and the *Phase* group appears on the screen.
5. Locate the *Mode* control within the *Phase* group.
6. Select the option *Linear*.

    The group changes appearance: *Start* angle and *Stop* angle controls are added to the group as well as a *Step* box and the step toggle, a small button labeled with the right angle bracket, >.
7. In the *Phase* group, single click several times on the toggle button marked >. The legend on the *Step* box toggles between *N Steps* and *Step (dg) Size*. Stop when the option *Step (dg) Size* is displayed.
8. In the *Phase* group, double click on the value inside the *Step Size* box, and type in *90*.
9. Locate the *Start* angle slider and indicator, and change it to 90 degrees.

10. Locate the *Stop* angle slider and indicator, and change it to 270 degrees.
    Tests reads 9; *Time* changes to 00:03.00.

This completes the setup of a three-test sequence that varies phase.

Specifying Repeating Tests

To specify that a test repeats four times:

1. Locate the *Repeat* control near the lower left corner of the SurgeWare window. The default setting is 1.
2. Change the value to four, either by typing the new value into the edit box or by clicking four times on the small up-arrow located just to the right of the box.
   The *Repeat N Times* icon appears in the *Order* group.
   Tests reads 36; *Time* changes to 00:12.00.

Modifying the Order of Events

In the default order of events for the nine-step sequence defined above, the simulator will step through the three voltage levels at the first phase angle, then increase the angle and step through the three voltage levels again, and so on. This is shown by the flowchart displayed in the *Order* group. The *Voltage* group icon is located in the inner loop of the chart.

Note
The icons in the Order group can be identified by comparing them to the icons located at the left of the Voltage, Surge, Coupling and Phase groups.

To reverse the order, that is, to force the phase angle to vary first at each voltage, do the following:

1. Position the mouse cursor over the *Voltage* icon.
2. Drag[4] the icon and place it on top of the *Phase* icon. The flow chart rearranges to show the new order of test.

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[4] To drag the icon, press and hold the left button of the mouse. Move the mouse while continuing to hold down the mouse button. To release the icon in a new location, release the mouse button.

Understanding BurstWare

The BurstWare window is similar to that shown in Figure 5-11. As various options are selected, parts of the display change and may differ from what is shown.

The BurstWare window contains several controls such as sliders, push button and list boxes. These are standard Microsoft Windows graphical objects, familiar to Microsoft Windows users. Even if you are new to Windows, you will find that the controls operate intuitively after just a few moments of experimentation.

The controls are clustered in groups that affect operation of BurstWare or define the parameters for a surge test. These groups include:

Menu Bar - Pull down menu provides access to on-line help, software and firmware version numbers, and allows saving, retrieving and renaming test files on disk.

Order Group - For test sequences that vary more than one EFT/Burst parameter, this group defines the order in which the tests and repetitions are run. In the group, there is an icon for each group of parameters that can vary. As test sequences are built, BurstWare arranges these icons into a flow chart. Modify the order of tests by dragging icons with the mouse to rearrange the flowchart.

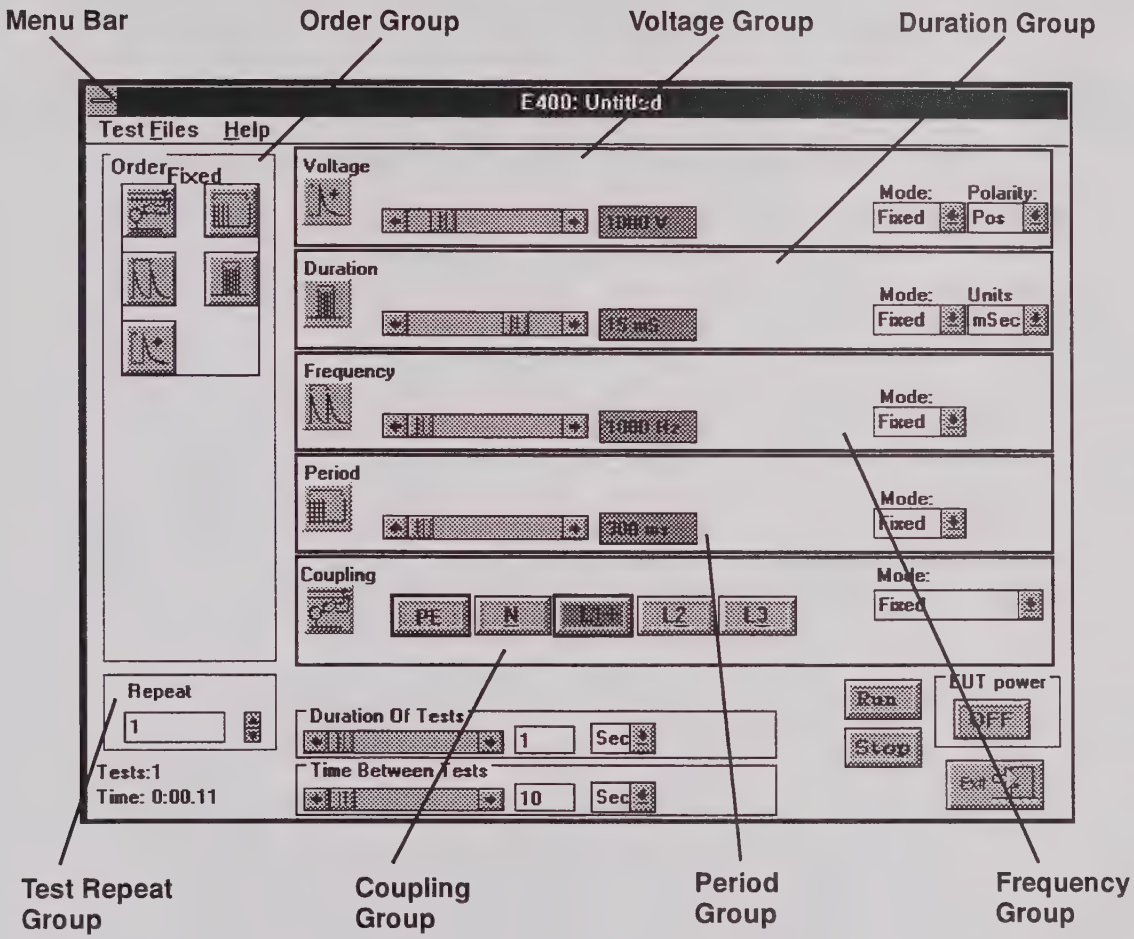

Figure 5-11. BurstWare Display

Voltage Group - Defines the voltage and polarity of individual EFT bursts and sequences of bursts. In a test sequence, voltage may step through a linear or logarithmic range or through a list of preset values.

Table 5-13 lists the controls unique to the *Voltage* group. The operation of the *Mode* control and the *N Steps* and *Step Size* controls, all of which are used in other groups, is described separately in Table 5-18 and the text following that table.

Table 5-13. EFT Voltage Group Controls

Control Name	Description	Values
Voltage icon	Passive, identifies which icon in the Order group symbolizes *Voltage*.	N/A
Voltage slider	Selects output burst voltage level.	Varies according to the type of network
Start and Stop sliders	Identifies the starting voltage and the upper limit test sequences that vary surge voltage in linear or logarithmic increments. Only present when *Mode* is *Linear* or *Log*.	0-4000 or 0-8000 depending on type of network.
List box Insert and Delete buttons	List box contains an entry for each set of voltage group parameters specified as a test step. The Insert button adds the presently specified surge voltage and polarity to the end of the list. The Delete button removes the highlighted entry; if no entry is highlighted, it removes the last entry. Only shown when *Mode* is *List*.	N/A
Step Size, N Steps, and step toggle buttons	*N Steps* defines how many additional[a] tests to run spanning the specified voltage range. *Step Size* defines how much the voltage is to increment in each test, until it exceeds the *Stop* level. The two options are mutually exclusive. When *Mode* is *Log*, only *N Steps* is available. When *Mode* is *Linear*, the step toggle button (marked with a >) is used to change between the two options. Only shown when *Mode* is either *Log* or *Linear*.	N/A
Mode	Defines whether a single value or a range of values is to be used for the *Voltage* parameter.	See Table 5-18
Polarity	Defines whether pulse polarity is to remain fixed (Pos or Neg) during a test sequence, or whether it is to alternate for every test or after every five tests.	Pos, Neg, Alternate 1 each, Alternate 5 each

[a] For *N Steps* equal four, a total of five tests will run.

Duration Group - Defines the length of an EFT pulse train either in milliseconds or in number of pulses. In a test sequence, *Duration* may be stepped through a linear or logarithmic range or through a list of preset values.

Table 5-14 lists the controls unique to the *Duration* group. The operation of the *Mode* control and the *N Steps* and *Step Size* controls, all of which are used in other groups, is described separately in Table 5-18 and the text following that table.

The entire *Duration* group is not shown when the *Mode* control in the *Frequency* group, described below, is set to *Chirp*.

Table 5-14. EFT Duration Group Controls

Control Name	Description	Values
Duration icon	Passive, identifies which icon in the Order group symbolizes *Duration*.	N/A
Duration slider	Selects output burst Duration in milliseconds or in pulses, according to the setting of the *Units* control.	1-20 ms or 1-200 pulses
Units indicator	Displays whether the value of the Duration Slider is in milliseconds or pulses	ms or pls
Start and Stop sliders	Identifies the starting value and the upper limit of *Duration* in test sequences that vary *duration* in linear or logarithmic increments. Only present when *Mode* is *Linear* or *Log*.	Min and max values same as Duration slider
List box Insert and Delete buttons	List box contains an entry for *duration* at each step in a test sequence. The *Insert* button adds the presently specified value to the end of the list. The *Delete* button removes the highlighted entry; if no entry is highlighted, it removes the last entry. Only shown when *Mode* is *List*.	N/A
Step Size, N Steps, and step toggle buttons	*N Steps* defines how many additional[a] tests to run spanning the specified range of *Duration*. *Step Size* defines how much the duration is to increment in each test, until it exceeds the *Stop* level. The two options are mutually exclusive. When *Mode* is *Log*, only *N Steps* is available. When *Mode* is *Linear*, the step toggle button (marked with >) is used to change between the two options. Only shown when *Mode* is *Log* or *Linear*.	N/A
Units control	Defines whether *Duration* is expressed in milliseconds or pulses.	ms or pls
Mode	Defines whether a single value or a range of values is to be used for the *Duration* parameter.	See Table 5-18

[a] For *N Steps* equal four, a total of five tests will run.

Frequency Group - Defines the pulse-to-pulse frequency in an EFT burst. In a test sequence, *Frequency* may be stepped through a linear or logarithmic range or through a list of preset values.

Table 5-15 lists the controls unique to the *Frequency* group. The operation of the *Mode* control and the *N Steps* and *Step Size* controls, all of which are used in other groups, is described separately in Table 5-18 and the text that follows that table.

Table 5-15. EFT Frequency Group Controls

Control Name	Description	Values
Frequency icon	Passive, identifies which icon in the *Order* group symbolizes *Frequency*.	N/A
Frequency slider and indicator	Selects the pulse-to-pulse frequency of the pulse train. The range of allowable values is determined by the *Units* control in the *Duration* group, described above. Not shown if *Mode* is *801-4* or *Chirp*	1,000-10,000 Hz or 1 kHz-1,000 kHz
Start and Stop sliders	Identifies the starting value and the upper limit of *Frequency* in test sequences that vary *Frequency* in linear or logarithmic increments. Only present when *Mode* is *Linear* or *Log*.	Min and max values same as *Frequency* slider
List box Insert and Delete buttons	Listbox contains an entry for *Frequency* at each step in a test sequence. The *Insert* button adds the presently specified value to the end of the list. The *Delete* button removes the highlighted entry; if no entry is highlighted, it removes the last entry. Only present when *Mode* is *List*.	N/A
Step Size N Steps Step Toggle	*N Steps* defines how many additional[a] tests to run spanning the specified range of *duration*. *Step Size* defines how much the duration is to increment in each test, until it exceeds the *Stop* level. The two options are mutually exclusive. When *Mode* is *Log*, only *N Steps* is available. When *Mode* is *Linear*, the step toggle button (marked with a >) is used to change between the options. Only shown when *Mode* is *Log* or *Linear*.	N/A
Mode	Defines whether a single value or a range of values is to be used for *Frequency*. Allows specifying the single fixed frequency of 5 kHz, as specified by the 801-4 standard, and also *Chirp*, which results in a continually changing pulse-to-pulse frequency.	The standard options for *Mode* (see Table 5-18) plus *Chirp* and *801-4*

[a] For *N Steps* equal four, a total of five tests will run.

Period Group - Defines the burst-to-burst period in a train of EFT bursts. In a test sequence, *Period* may be stepped through a linear or logarithmic range or through a list of preset values.

Table 5-16 lists the controls unique to the *Period* group. The operation of the *Mode* control and the *N Steps* and *Step Size* controls, all of which are used in other groups, is described separately in Table 5-18 and the text that follows that table.

Table 5-16. EFT Period Group Controls

Control Name	Description	Values
Period icon	Passive, identifies which icon in the Order group symbolizes *Period*.	N/A
Period slider and indicator	Selects the burst-to-burst period of the pulse train.	300 ms - 5,000 ms
Start and Stop sliders	Identifies the starting value and the upper limit of *Period* in test sequences that vary *Period* in linear or logarithmic increments. Only present when *Mode* is *Linear* or *Log*.	Min and max values same as *Period* slider
List box Insert and Delete buttons	Listbox contains an entry for *Period* at each step in a test sequence. The *Insert* button adds the presently specified value to the end of the list. The *Delete* button removes the highlighted entry; if no entry is highlighted, it removes the last entry. Only present when *Mode* is *List*.	N/A
N Steps, Step Size, and step toggle buttons	*N Steps* defines how many additional[a] tests to run in spanning the specified range of *Period*. *Step Size* defines how much the duration is to increment in each test, until it exceeds the *Stop* level. The two options are mutually exclusive. When *Mode* is *Log*, only *N Steps* is available. When *Mode* is *Linear*, the step toggle button (marked with a >) is used to change between the options. Only shown when *Mode* is *Log* or *Linear*.	N/A
Mode	Defines whether a single value or a range of values is to be used for *Period*.	See Table 5-18

[a] For *N Steps* equal four, a total of five tests will run.

Coupling Group - Defines the EFT/Burst coupling. Specifies whether the pulse train is coupled directly to the output of the EFT/Burst source or through specified power lines using the coupler/decoupler. When output is through the coupler/decoupler, you specify the lines to which the surge is coupled either for a single test or for a sequence of tests.

The group provides two shortcut buttons for instantly defining often-used test lists. One creates a list that includes all coupling possibilities, the other creates a smaller list of standard couplings appropriate to the coupler/decoupler in use. This is especially helpful for three phase couplers where there are a dozen standard tests and over sixty possible combinations.

Table 5-17 lists the controls unique to the *Coupling* group. The operation of the *Mode* control used in other groups is described separately in Table 5-18 and the text that follows that table.

Table 5-17. EFT Coupling Group Controls

Control Name	Description	Values
Coupling icon	Passive, identifies which icon in the Order group symbolizes Coupling.	N/A
Invalid Mode indicator	Displays when specified coupling is invalid, missing or incomplete (i.e., when only surge Hi or Lo is specified).	N/A
Coupling buttons	Specifies which surge output, if any, is coupled to each power line. The symbol + appears when a line is connected to EFT/Burst. Each time the button for a line is clicked, it toggles between connected and unconnected.	+ or none (blank)
Coupling list box, Insert and Delete buttons	List box contains an entry for *coupling* at each step in a test sequence. The *Insert* button adds the presently specified value to the end of the list. The *Delete* button removes the highlighted entry; if no entry is highlighted, it removes the last entry. Only present when *Mode* is *List*.	N/A
Mode	Defines whether a single value or a range of values is to be used for *Voltage*.	Standard *Mode* options (see Table 5-18), also includes *All* and *Standard* options.

Miscellaneous indicators and controls - There are various other indicators and controls located in the SurgeWare window, including:

- *Run, Stop and Step buttons* - Push buttons, located lower right, that start a test, stop it, or manually step the simulator through a test sequence.
- *EUT Power button* - Push button, located lower right, that enables or disables the EUT power system. When the button legend is *Off*, the EUT power system is disabled, when the legend is *READY*, the system is enabled. The push button does not actually control EUT power. For safety reasons, power must manually be turned on using the switch *EUT Mains*, located on the ECAT control center.
- *Exit button* - Located lower right, shuts down BurstWare and returns control to Microsoft Windows.
- *Tests* - Displays the total number of tests defined in the current sequence. While a sequence is running, this indicator displays the number of the step currently running. Located lower left of screen.
- *Time* - Displays, in days plus 24 hour format, the total time for the current test sequence to run from start to finish. This value is the product of the number of tests times the time between tests. Located lower left of screen.
- *Test Repeat Group* - Defines how many times the specified test or a test sequence is to run. Range is 1 - 9999, default is 1.
- *Duration of tests* - This group of controls defines how long a test sequence is to run. Minimum duration is one second; maximum is 24 hours. This is a global setting that remains in effect for all tests in a sequence. However, the duration of a test may be changed on-the-fly during a test sequence by pausing the sequence, changing the setting, and then resuming.
- *Time between tests* - This group of controls defines the time between tests in a test sequence. Minimum time is one second; maximum time is 24 hours. This is a global setting that remains in effect for all tests in a sequence. However, the time between tests may be changed on-the-fly during a test sequence by pausing the sequence, changing the time, and then resuming the run.
- *Status* - At the right side of the *Time between tests* group, a status indicator shows whether the ECAT system is idle. While a test is running, a countdown timer appears within the group showing the time remaining until the next test begins.

***Mode* control** - A special listbox that appears in several control groups: *Voltage, Duration, Frequency, Period* and *Coupling*. The mode function allows the setup of various kinds of test sequences. As *Mode* is invoked in a control group, the configuration of that group changes, providing access to the functions unique to that mode. The *mode* controls are listed and described in Table 5-18. Additional information about the controls *Step Size* and *N Steps* follows the table.

Table 5-18. Mode Controls in BurstWare

Option Name	Description
Fixed	Specifies the control group mode is *fixed*. The parameters set up in the control group remain constant - either for single test, or while parameters in other control groups are allowed to vary in a test sequence.
List	Specifies the control group mode is *list*. Adds a *List* display plus *Insert* and *Delete* buttons to the group. Build a test sequence by adding individual tests one at a time using *Insert*. A list is persistent; it remains in existence until it is explicitly cleared with *Delete* or with *NewList* which clears the entire list. However, when the list is not visible on the screen (i.e., when mode is *Linear*, *Log* or *Fixed*) the list becomes inactive and is ignored during a test run.
Linear	Specifies the control group mode is *linear*. Adds *Start* and *Stop* limits which define the range of values the parameter will span. Also adds *N Step* and *Step Size* buttons (see accompanying description). For each step in the test sequence, the value of the variable parameter increases in linear steps until the stop limit is reached.
Log	Specifies the control group mode is *logarithmic*. Adds *Start* and *Stop* limits which define the range of values that the parameter will span. Also adds the *N Step* box (see accompanying description). For each step in the test sequence, the value of the variable parameter increases in logarithmic steps until the stop limit is reached.
New List	Clears the current list, if one exists, and then sets mode to *List*.
801-4, Chirp	Special mode settings for the *Frequency* group. Refer to the description of the *Frequency* group above for details.
E4xx-Out1, All, Standard	Special mode settings for the *Coupling* group. Refer to the description of the *Coupling* group above for details.

***N Steps* control** - (*Log* mode only) - An edit box displaying how many additional test steps, beyond the start value, span the test range defined by the *Start* and *Stop* controls. That is, if *N Steps* is four, a total of five tests will run.

***Step Size/N Steps* controls** (*Linear* mode only) - A group of two controls - a button and an edit box that defines how much a value increments as it steps through a linear range of values. The button, marked with a >, controls the meaning of the value in the edit box. Clicking the button toggles the box between *Step Size* and *N Steps*.

When the edit box is labeled *Step Size*, the value in the box shows how many units are added to a parameter for each new test in the sequence. The total number of steps is calculated accordingly. For example, if *Voltage* is set to span the linear range 2000 V to 3000 V with a step size of 100, eleven tests will run.

When the edit box is labeled *N Steps*, its meaning is as described in the table above for *Log*.

EFT/Burst Testing from BurstWare

Single-shot EFT/Burst tests are initiated from BurstWare as follows:

- Enter EFT/Burst parameters
- Enable and turn on power to the EUT, if power is supplied through an ECAT module
- Click on *Run* to start the test

Test sequences are defined and run similarly. The only difference between single-shot and sequence is that instead of defining a single set of EFT/Burst parameters, several sets of parameters in one or more of the control groups are defined.

EFT/Burst parameters define the nature and coupling of the pulse or pulse train. For each burst parameter, BurstWare displays all the allowable values based on which instrument modules and options are installed in the ECAT system.

EUT power is enabled from the *EUT Power* group and is then manually turned on with the blue *EUT Mains* switch on the ECAT control center, located at the upper right of the system.

Note

EUT power is not on unless all of the EUT power override conditions are cleared and all interlocks are met. When EUT power is on, the blue indicator in the switch turns on.

High voltage does not actually charge up unless all interlocks are met. The loss of any interlock immediately disables and internally discharges the high voltage system.

Example: Building a Test Sequence

The following procedure illustrates the building of a test sequence. The example builds a sequence of nine tests in which two parameters are varied. In this sequence:

1. *Voltage* is varied in three steps using a test list.
2. *Frequency* is varied in three linear steps through a test range.
3. Icons in the *Order* group are used to modify the default order of tests.

The sequence assumes the ECAT system includes the Model E411 EFT/Burst network. Since the purpose of this example is to illustrate the setup of a sequence, running the test or viewing the output waveform on a scope is not described here.

In a test sequence, variations in test parameters run cumulatively, not consecutively. That is, for each parameter value at one *Voltage* setting, all values of *Duration* are run. For that reason, in this example with three tests in one group and three tests in another, the total number of tests is nine not six.

Initial Setup

In all of the following procedures the term *keyboard* refers to the computer keyboard, not the ECAT system keypad.

1. Turn on the ECAT system.

   If the system is already running, momentarily power it down and restart it to ensure that all conditions match the descriptions that follow.
2. Start BurstWare on the computer.

   If BurstWare is already running, exit the program and restart it so the initial values of the controls tracks the following descriptions.
3. Locate the two indicators *Tests* and *Time* in the lower left corner of the BurstWare window. They read *Tests:* 1 and *Time:* 00:00.11. As tests are added to the sequence, these values change.

Defining the Test List for Voltage

This procedure defines a test list with the following surge voltages: 1050, 2000 and 3000.

1. Locate the *Voltage* group control marked *Mode*.
2. Single click on the arrow at the right of the control to pull it down and display all the available options.
3. Click on the option *New List*.

   The group changes appearance: *Insert* and *Delete* buttons are added as well as an empty test list.

4. Locate the voltage slider and display inside the *Voltage* group. The voltage display reads 1000 V.
5. Single click five times (slowly) on the arrow at the right of the slider. The *Voltage* display increases by 10 volts with each click. Stop at 1050 V.
6. Click the *Insert* button located within the *Voltage* group. The 1050 V setting is added to the test list. The indicators *Tests* and *Time* remain unchanged because there is still only one test defined.
7. Double click on the number 1050 inside the *Voltage* edit box. The contents of the box are highlighted.
8. Type in the value 2000. The value 2000 V appears in the box.
9. Click the *Insert* button again. This adds the 2000 Volt setting to the test list.

   Tests changes to 2; *Time* changes to 00:00.22.
10. Position the mouse cursor over the *Voltage* edit box again. Notice the cursor changes from an arrow to the I-Beam. Position the cursor to the left of the 2 in 2000, and single click. Press the *Delete* key on the keyboard and then type in the digit 3. The edit box displays 3000 V.
11. Click the *Insert* button again. This adds the 3000 Vsetting to the list.

    Tests changes to 3; *Time* changes to 00:00.33.

This completes the setup of a three-test sequence for varying voltage.

Note

In the steps below, the sequence of mouse clicks is omitted, and is replaced with the phrase 'select the option'.

Defining the Test Range for Frequency

This procedure defines a test range with the length of the burst varying from 100 pulses to 200 pulses in three linear steps, resulting bursts of 100 pulses, 150 pulses and 200 pulses.

1. Locate the *Mode* control in the *Frequency* group.
2. Select the option *Linear.*

   The group changes appearance: *Start* and *Stop* controls are added to the group as well as the *Step Size* box and the step toggle, a small button labeled with the right angle bracket, >.
3. Click several times (slowly) on the toggle button marked >. The legend on the *Step* box toggles between *N Steps* and *Step (kHz) Size.* Stop when the option *Step (kHz) Size* is displayed.

4. Double click on the value inside the *Step Size* box, and type in *50*.
5. Locate the *Start* slider and indicator, and change it to 100 kHz.
6. Locate the *Stop* slider and indicator, and change it to 200 kHz.

   The indicator *Tests* reads 9; the indicator *Time* changes to 00:01.39.

This completes the setup of a three-test sequence that varies *Frequency*.

Modifying the Order of Events

In the default order of events for this nine-step sequence, the simulator steps through the three voltage levels at the first burst duration, then increases the duration and steps through the three voltage levels again, and so on. This is shown by the flowchart displayed in the *Order* group. The *Voltage* group icon is located in the inner loop of the chart.

Note
The icons in the Order group can be identified by comparing them to the icons in the control groups

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To reverse the order - that is, to step through all three burst duration settings at each voltage - do the following:

1. Position the mouse cursor over the *Voltage* icon.
2. Drag[5] the icon and place it on top of the *Frequency* icon. The flow chart rearranges to show the new order of test.

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[5] To drag the icon, press and hold the left button of the mouse. Move the mouse while continuing to hold down the mouse button. To release the icon in a new location, release the mouse button.

Understanding PQFWare

The PQFWare window is similar to that shown in Figure 5-10. As various options are selected, parts of the display change and may differ from what is shown.

The PQFWare window contains several controls such as sliders, push buttons and list boxes. These are standard Microsoft Windows graphical objects, familiar to Microsoft Windows users. Even if you are new to Windows, you will find that the controls operate intuitively after just a few moments of experimentation.

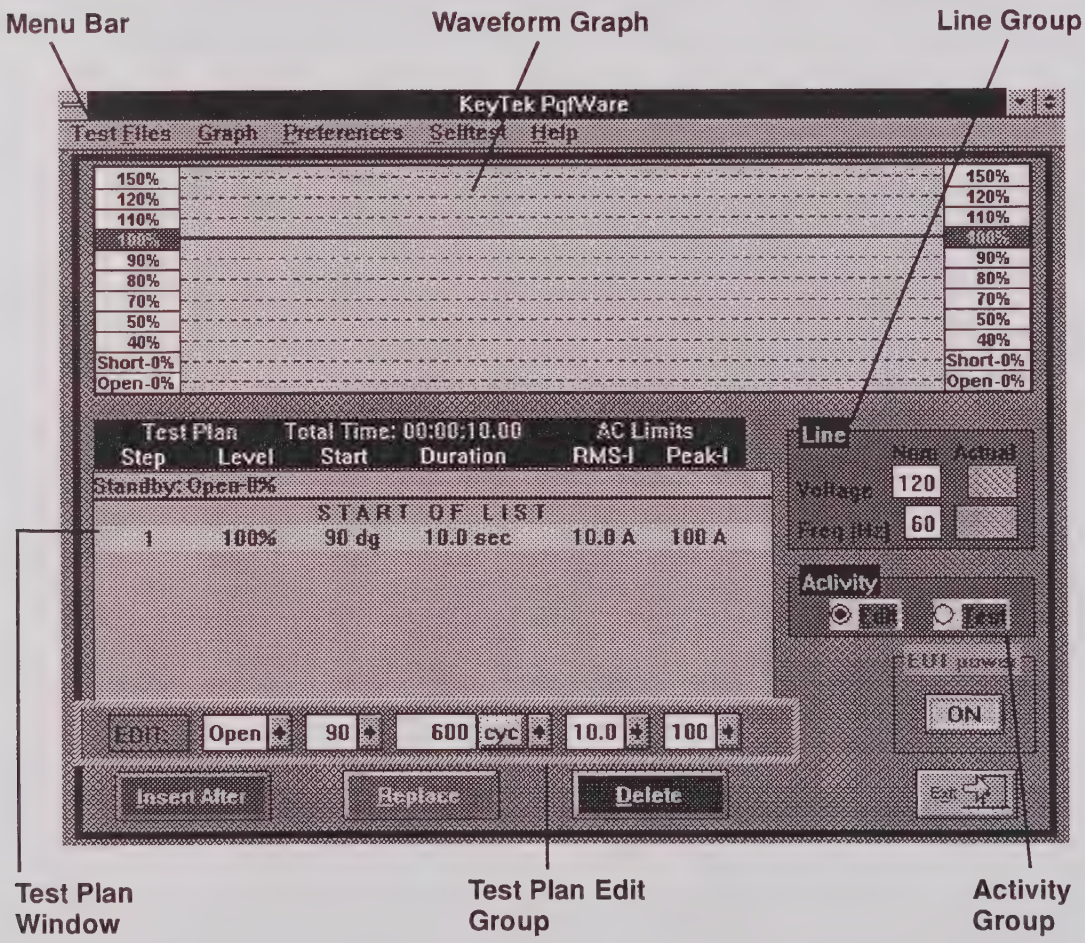

Figure 5-12. PQFWare Display

The controls are clustered in groups that affect operation of PQFWare or define the parameters for a PQF test. These groups include:

Menu Bar - Pull down menu provides access to on-line help, software and firmware version numbers, and allows saving, retrieving and renaming test files on disk. It also includes an option for qualifying the AC line inrush capability.

Waveform Graph - A graph of the test sequence currently defined in the test plan. The width of each event on the graph is proportional to the time duration of the event. By default, the graph is self scaling; that is, all of the events listed in the test plan are displayed between the left and right edges of the graph.

Two menu functions are available under *Graph* on the menu bar for adjusting the graph scale.

- *Zoom in* - Allows magnifying a portion of the graph. The area to be magnified expands to fill the graph, and a scroll bar appears below the graph showing the approximate location of the magnified area relative to the entire waveform. Several successive levels of zoom are allowed. At maximum magnification, the full width of the graph represents approximately 80 ms.

  Pressing the right mouse button on the graph also invokes the *Zoom in* function. When the *Zoom in* function is invoked, the mouse cursor changes to a cross hair, so the area to be magnified can be marked by clicking and dragging with the mouse.

- *Zoom out* - Resizes the graph so the entire test plan is shown between the left and right edges of the graph.

If the test plan is empty, the *Zoom* controls are disabled.

Test Plan Window - Defines the list of PQF events that make up a test sequence. For each step, the following parameters are defined:

- Output level, expressed as a percentage of line voltage. Allowed values include 0% - short circuit, 0% - open circuit, 40%, 50%, 70%, 80%, 90%, 100%, 110%, 120%, 150%.
- Starting phase, in degrees. Allowed values are the range 0 degrees to 359 degrees.
- Duration in cycles (cyc), minutes plus seconds (m:s), or seconds (sec). Allowed ranges of values are 0-9999 cycles, 00:01 - 500:59 minutes:seconds, and 0 - 99.9 seconds.
- AC current limits, stated both in RMS and peak values. Allowed ranges of values are 0-32 A (RMS current) and 0-500 A (peak current).

If there are more items in the list than can fit in the window, a scroll bar appears to the right of the window.

The *Test Plan* window also displays the *Standby* setting for the PQF generator. This specifies the power level that is applied to an EUT when *EUT Power* switch on the ECAT system is turned on and the PQF generator is **not** running a test sequence.The allowed values are either *100%* (power on) or *Open* (power off).

Test Plan Edit Group - The test plan edit controls are located just below the test plan window. The controls in this group are used to insert, replace or delete individual steps in a test sequence. Controls are available to set each parameter for a step.

Table 5-16 lists the *Test Plan Edit* controls. Taken together, the controls define a new test step. The new step is not actually added to the test sequence until either the *Insert After* or the *Replace* push button is clicked.

Double clicking an item in the test list copies the parameters for that step into the Test Plan Edit group, described next.

The *Test Plan Edit* controls are also used to set the *Standby* power level that is shown in the test plan window. The *Standby* voltage setting is restricted to *0% - Open* and *100%*. To change the standby level, move the list cursor in the test plan to *Standby*, change the setting, and press *Replace*.

The first five controls listed in the table are indicator boxes paired with a hidden slider or scroll bars. By default, the slider appears when the small push button (marked with a right arrow) to the right of the control indicator box is clicked. However, this behavior is influenced by the settings of *Automatic Scroll bar Popup* and *Automatic Scroll bar Release*, which appear under *Options* on the menu bar, as follows:

- ***Automatic Scroll bar Popup*** - When this option is turned off (unchecked) the slider of each control set appears only when the push button is clicked. When the option is turned on (checked) the slider appears automatically whenever the mouse cursor passes over the right arrow push button.
- ***Automatic Scroll bar Release*** - When this option is turned off (unchecked) the slider of each control becomes hidden only when the indicator box of the control set is clicked. When this option is turned on (checked) the slider becomes hidden automatically when the mouse cursor moves away from the slider.

Table 5-19. Test Plan Edit Group Controls

Control Name	Description	Values
Level	Specifies the voltage level for the new step defined in the edit group.	0% - Open, 0% - Short, 40%, 50%, 70%, 80%, 90%, 100%, 110%, 120%, 150%
Start	Specifies the starting phase angle[a] when the new step in the edit group is to be applied.	0 - 359 (degrees)
Duration and Units	Specifies the duration and units of the new step in the edit group. Units include seconds, minutes and seconds, and cycles.	0 - 9999 (cycles) 0 - 99.9 (seconds) or 00:01 - 500:59 (minutes:seconds)
RMS Current Limit	Defines the maximum allowable RMS current to the EUT. If this limit is exceeded, the test sequence in progress is halted and EUT power is shutdown.	1 - 32 A Enter 0 to disable RMS current limit checking.
Peak Current Limit	Defines the maximum allowable peak current to the EUT. If this limit is exceeded, the test sequence in progress is halted and power is shutdown.	1- 100 A Enter 0 to disable Peak current limit checking.
List cursor	A color bar that shows the insert point in the test plan. The step highlighted in the list is also highlighted in the graph.	N/A
Insert After	Pressing this button inserts the new step defined in the edit group into the test plan at the location below the list cursor. To insert a new step at the start of the list, move the cursor to *Start of List*.	N/A
Replace	Pressing this button replaces the highlighted step in the test plan with the new step defined in the edit group. The control has no effect if the cursor is at the *Start of List*.	N/A
Delete	Pressing this button deletes the highlighted step in the test plan. The control has no effect if the cursor is at the *Start of List*	N/A

[a] If there is a slight gap during a test sequence between the end of one step and the start of a new one, the previous step is extended slightly until the new step begins. This can happen, for example, when a step starting at phase angle of 0 degrees with a duration stated in cycles is followed by a step starting at a phase angle of 90 degrees.

Line Group - The line group is used to define the nominal settings of the AC power source and provides a readout of the actual values measured when EUT power is turned on.

Activity Group - The activity group is used to change the mode of PQFWare between running a test or editing the test sequence. When *Edit* is chosen, the *Test plan edit* controls are visible on the screen. When *Test* is chosen, the *Run, Stop* and *EUT Power* controls appear and the *Test plan edit* controls become hidden.

Miscellaneous indicators and controls - There are various other indicators and controls located in the SurgeWare window, including:

- *Run, Stop buttons* - Push buttons, located lower right, that start or stop a test.
- *EUT Mains button* - Enables EUT power turn on.
- *Exit button* - Located lower right, shuts down PQFWare and returns control to Microsoft Windows.
- *Repeat Test*- Specifies that the test should loop from the last step back to the first until manually halted.
- *Actual AC* - Displays actual measured values of RMS and peak current.

PQF Testing from PQFWare

PQF tests are initiated from PQFWare as follows:

- Enter the parameters for each step in the PQF sequence
- Enable and turn on power to the EUT
- Click the *Test* button in the *Activity* group
- Click on *Run* to start the test

PQF parameters define each step in a sequence. For each parameter, PQFWare displays all the allowable values based on which instrument module and options are installed in the ECAT system.

EUT power is enabled from the *EUT Power* button and then must be manually turned on by a push button on the ECAT control center, located at the upper right of the system. Power does not actually turn on unless all interlocks are met. The loss of any interlock immediately disables the module and shuts down any test in progress.

Note

EUT power is not on unless all of the EUT power override conditions are cleared and all interlocks are met. When EUT power is on, the blue indicator in the switch turns on.

For an example of setting up a PQF test, refer to the topic *Performing a Simple PQF Test* in Chapter 4, *Familiarization*.

Chapter 6
Maintenance, Troubleshooting

There are no user-serviceable parts in the ECAT system. All maintenance and repairs must be performed by KeyTek at the factory or by a qualified KeyTek service center. The recommended maintenance intervals are described below.

Table 6-1, which begins on the next page, can be used to help isolate operational problems and to eliminate common possibilities before contacting KeyTek for further help.

Annual Calibration

KeyTek recommends that the equipment be calibrated annually. This can be done at the factory or by qualified KeyTek service centers. Use the original shipping materials or obtain a new set from KeyTek.

Five-year Factory Inspection and Refurbishment

During normal use, the high voltage components in the system are subjected to substantial electrical stress and may wear out over time. For this reason, KeyTek recommends that the equipment be returned every five years to the factory or to a qualified KeyTek service center for inspection and refurbishment.

The inspection and refurbishment program inspects components and replaces those that show normal deterioration exceeding certain limits.

Failure to return the equipment for inspection and refurbishment may create a safety hazard and may invalidate some or all of the KeyTek warranty on the equipment. Use the original shipping materials or obtain a new set from KeyTek.

Updating the ECAT Firmware

The ECAT system is designed to allow firmware update in the field. The ECAT system must be equipped with the FiberCom option. The update process uses a PC connected to the FiberCom port located on the back of the System Control Center. When the ECAT system is used in concert with a Microsoft Windows computer running SurgeWare, the PC on which SurgeWare runs may be used for updating the firmware.

Caution

If system power is interrupted during a firmware update, or if the FiberCom cable is disconnected during the process, the contents of the ECAT system control PROMs may be left in a state that prevents the ECAT system from running.
If this happens, new PROMs must be obtained from KeyTek. The update process takes about 2 minutes.

The updated firmware and the update program are supplied on diskette. Follow the procedure below to update the firmware:

If the system is already under the control of SurgeWare, skip the following step.

1. Connect the COM1 serial port of a PC to the ECAT system via the FiberCom connector on the back of the instrument. If necessary, consult the installation procedures for connecting FiberCom in Chapter 3, *Installing the ECAT System*.

Note

Optionally, the COM2 port may be used. If using COM2, follow the alternate procedure for COM2 as given below.

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2. Power up the ECAT system and power up the PC.
3. After the PC is up and running, insert the update diskette into the diskette drive.

The update may be performed using Microsoft Windows 3.x[1] or from the DOS prompt.

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[1] Windows 3.x refers to Microsoft Windows™, Version 3.1 and later.

Updating the ECAT Firmware from Microsoft Windows

1. Make Program Manager, File Manager or an equivalent Windows shell the current active window.
2. Pull down the *File* menu and select *Run*. Windows displays a dialog box requesting the name and path of the program.
3. Enter the diskette unit drive path, followed by UPDATE, for example:

   A:\UPDATE.EXE

   Alternately, for COM2 enter:

   A:\UPDATE.EXE COM2
4. Click *OK*.
5. Follow the instructions on the screen to complete the update.
6. Power down the ECAT system and then power it up again.

Updating the ECAT Firmware from DOS

1. Make the drive with the update diskette the active drive by typing:

   A:[Enter]

   or

   B:[Enter]
2. Type in the following command:

   UPDATE [Enter]

   Alternately, for COM2, type:

   UPDATE COM2 [Enter]
3. Power down the ECAT system and then power it up again.
4. Follow the instructions on the screen to complete the update.

Troubleshooting

Table 6-1. ECAT System Trouble Shooting Guide	
Symptoms	**Check that: / Solutions**
Overall System	
No lights, no display on Virtual Front Panel when power is turned ON.	1. Line cord is plugged into power source. 2. Red button is in the **OUT** position. 3. Line fuse on Controller is not blown out.
Random crashing of ECAT Controller	1. Fiber cable (FC-11) is plugged into the computer and the ECAT, or the FiberLoop connector, T_x or R_x, has a rubber plug installed. 2. Make sure that the FiberLoop jumper is installed.
Microsoft Windows Message "Unable to Communicate"	1. Make sure that the fiber cable (FC-11) is plugged into the computer and the ECAT. 2. FC-11 is connected to correct comm port. See *Changing the COM Port* in Chapter 3. 3. Computer is set-up correctly; refer to Chapter 3 on Computer Setup.
Intermittent operation of ECAT if computer is a laptop operating on battery power.	Plug the AC adapter into the laptop.
Unknown Interlock message - interlock conditions cannot be identified.	1. Plug-in modules are properly seated. Reseat as required. 2. If a bay motherboard was recently added, affirm that the blue jumper on the ECAT bay was moved to the bottom bay. 3. Re-tighten module hold down screws.
Blue Button will not turn EUT Mains on.	1. Enable EUT power through Microsoft Windows software or Virtual Front Panel. 2. Close interlock, then move Blue button from **OUT** to **IN** position to activate EUT power.

Table 6-1. ECAT System Trouble Shooting Guide *continued*	
Symptoms	**Check that: / Solutions**
No output from Voltage or Current Monitor coax and no peak detector measurement.	1. Select measurement source and menu in Microsoft Windows or Virtual Front Panel. 2. Voltage monitor jumpers are placed in the location selected on the menu.
VFP	
Virtual Front Panel value changes when leaving a field or hitting RUN.	Must press **ENTER** after changing numeric values and before starting a test.
Unable to select line sync or coupling mode.	You must first select output at coupler/decoupler. Note: For EFT, Output 2 does not enable coupler/decoupler selection. You must first select coupler/decoupler.
Unable to select a module in Virtual Front Panel; selection of module does not appear in Microsoft Windows **Help** box.	Reseat the module.
No response when pressing **START.**	For surge, press **F1** for charge, and press **F3** for pulse.
Modules	
No output from Surge Test.	1. Wait until Controller beeps and displays ready before striking **F3** to pulse. Striking any key before charge delay is completed will cancel charging sequence. 2. Module selections are correct. 3. Output connections are placed at selected **output at** locations. 4. Proper polarity is selected.
No EFT output from Coupler/Decoupler.	1. Coupler/Decoupler is selected as output device. 2. With separate EFT source and coupler/decoupler modules, KeyTek supplied cable must be used to connect EFT source OUT 2 to coupler/decoupler.

Table 6-1. ECAT System Trouble Shooting Guide *continued*	
Symptoms	**Check that: / Solutions**
PQF	
Tester Error: Over-temperature Fault.	Proper ventilation is being achieved: Be sure cooling vents are clear; and filters are not clogged with dust or dirt.
Tester Error: Snub BUS Voltage exceeded.	Input mains rating exceeded; load may be generating excessive voltage at output of PQF.
Tester Error: Over-current Fault.	EUT failure may have occurred. Check EUT connections Disconnect EUT and rerun test. If problem persists, consult Keytek.
Too many taps selected.	1. Maximum number of taps is two not including 100% or Open. 2. Increasing minimum step duration to greater than 6 cycles or 0.1 seconds will also alleviate problem and will allow any number of taps to be selected.
Sequence ends after one pass through.	Insert a **go to** in Virtual Front Panel or select **Repeat** in Microsoft Windows.

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